Middle Maitland

CONSERVATION REPORT . . . 1954

DEPARTMENT OF PLANNING AND DEVELOPMENT

The water of the Middle Maitland comes mostly from surface run-off, tile drains and drainage ditches in the clay plain of the headwaters. About three miles west of Brussels it enters the country of rolling hills where it flows through wide valleys with stony bottomlands.

DEPARTMENT OF PLANNING AND DEVELOPMENT

THE HONOURABLE W. K. WARRENDER, Minister

A. H. RICHARDSON, Chief Conservation Engineer

MIDDLE MAITLAND VALLEY CONSERVATION REPORT 1954

ONTARIO

TORONTO
1954

Two hundred copies of this report have been prepared, of which this is

Number 111

Honourable W. K. Warrender, Minister,

Department of Planning and Development,

Parliament Buildings,

Toronto, Ontario.

Honourable Sir:

I take pleasure in transmitting herewith a Conservation Report on the Middle Maitland Valley.

The report is in two sections: Forestry and Water.

Yours very truly,

A. H. Richardson
Chief Conservation Engineer

Toronto, May 13, 1954.

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The Conservation Branch is also indebted to the London Free Press for the illustration of the 1948 flood, to Mr. R. J. Russel for the illustrations of the floods of 1912 and 1948, and to Mr. A. T. Elliott for the illustrations of the 1954 flood.

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INTRODUCTION

Conservation has long been a subject of concern to the people of Ontario. This concern had to do originally with the protection of forests because of their importance as a source of revenue to the Province; but allied with this was the problem of wildlife management and the protection of source areas of rivers and streams. In Southern Ontario interest in conservation was indicated first by reforestation and woodlot management, but more recently this has broadened out to include flood and pollution control, improved land use and provision for recreation facilities.

While the progress in these activities has been steady up to the present, most of the programs heretofore were initiated by government departments. Recently, however, there has been a growing conception of personal obligation, especially where land use problems, farm ponds and small reforestation projects are concerned. On the other hand, control of flooding, summer flow and pollution, and large reforestation projects have come to be considered the responsibility of the community - the community in this case being the river valley.

With the advent of this new concept of personal and community responsibility in conservation, the Authorities movement was born, and the willingness of our people to undertake conservation in this way is indicated by the fact that since the Act was passed 17 Authorities have been established on 21 watersheds with a total membership of 269 municipalities and an area of 11,148 square miles.

The first step in establishing a Conservation Authority is undertaken by all the municipalities wholly or partly within a watershed. Two such municipalities must first by resolution petition the government to call a meeting for the purpose of ascertaining whether or not an Authority should be established. Two-thirds of the number of representatives which

the municipalities are entitled to appoint (on a population basis) must be present to make the meeting legal. If two-thirds of those present vote in favour of establishing an Authority a resolution is forwarded to the Minister of Planning and Development. The Authority is then established by Order-in-Council and under the Act becomes a body corporate, including representatives from all the municipalities in the watershed.

While most of the Authorities were brought into being because of flooding within their areas, all were aware of the necessity of carrying out such supplementary measures as improved methods of land use, reforestation, proper woodlot management, prevention of pollution, investigation of underground water supplies, wildlife studies and recreation. But the Authorities were not equipped to carry out the extensive investigations that would indicate where such work should be done. Consequently the Conservation Branch of the Department of Planning and Development undertook to make the preliminary investigations as a service to the Authorities, to appraise, by means of surveys and reports, the conservation needs of each watershed, and to submit to the Authority a detailed report outlining the conservation measures that should be followed.

The survey work is grouped under five general headings: Land Use, Forestry, Hydraulics, Wildlife and Recreation. The scope of the studies made in each of these subjects varies with the condition and needs of the area under investigation, with the result that in the completed report the findings recorded for each subject are related to the problem involved. In addition to the five conservation topics indicated above, a study covering the history of the area is incorporated. This serves as a backdrop to the whole conservation problem of the watershed and compels the reader to understand the abuses of the past and the need for a diversified program in the future.

The starting point for all surveys is aerial photography; in preparation for the work which has been done on each of the watersheds covered to date, the area was first specially photographed. Before the survey is commenced in the field all such contributing data as maps, old records, photographs, unpublished reports and other useful information are thoroughly explored and recorded. While the survey is in progress similar data are gathered locally, and agricultural representatives, zone foresters, municipal clerks, other officials and private citizens are interviewed for additional material.

The results of these conservation surveys, together with the recommendations based upon them, are set down in the reports presented to the Authorities and intended to serve them as a blueprint. The carrying out of any scheme is not the work of the Conservation Branch of the Department of Planning and Development, which is not an operating department. Its active participation ceases when the planning is complete and the report is submitted, although it stands by to interpret the report and give advice and assistance in carrying out the plans recommended to the Authorities. The Authority must assume responsibility for initiating the schemes which it considers most urgent; it must also make approaches to the government departments or other bodies from which it hopes to get assistance.

If, for example, an Authority undertakes a scheme having to do with land use, it must seek assistance from the Department of Agriculture: if it involves a forestry or wildlife problem, then the Department of Lands and Forests is approached: if it concerns pollution the Authority must deal with the Department of Health. In the case of flood control, however, as there is no department of the government doing hydraulic surveys except the Conservation Branch, whose staff is not large enough to carry through the engineering works of

several Authorities, the Authority must engage a consulting engineer to do the final engineering and designing and to carry the work through the construction stage. Similarly, where an Authority undertakes a scheme which has to do with recreation, it must employ men especially trained in this work.

As the work being done by Authorities is a new approach to the conservation problem, in that the responsibility of carrying it out is left entirely in the hands of the Authority concerned, much directing and assistance have been necessary from the Conservation Branch, and in the case of seven Authorities, a member of the staff of the Department of Planning and Development has been assigned to work in the watershed.

The Middle Maitland Valley Conservation Authority was established by Order-in-Council on September 6, 1951, following an organization meeting which was held at Listowel on June 26, 1951, when 13 representatives out of a total of 15 attended the meeting and voted in favour of establishing the Authority.

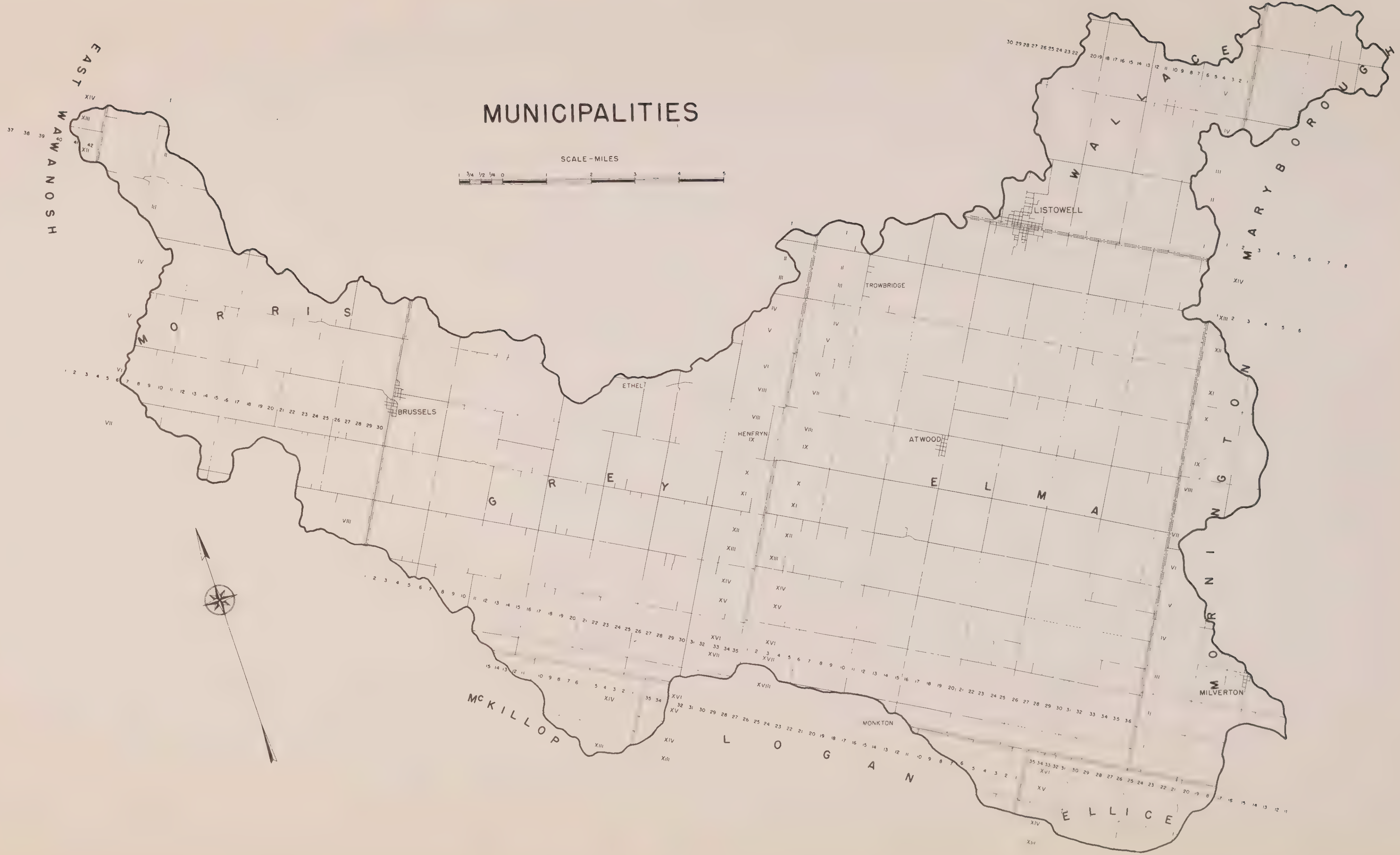
As mentioned above, the Department of Planning and Development, as a service to an Authority, undertakes to carry out a conservation survey of the valley for the guidance of the Authority, but the commencement of conservation work in the valley does not necessarily have to wait until such a survey has been made and the report presented. This is the case with many Authorities, and much excellent work has been done independent of the reports which have been prepared by this Department.

The terrain of the Middle Maitland is very flat, and floods and drainage have always been serious problems. Much of the land which was originally swamp has been converted to agriculture by artificial drainage. However, it is frequently found that attempts to drain the central portions of these swamps result in failure. It is impossible to get the water

away from them and pasture cannot be maintained. They become covered with dense thickets of scrub willow and dogwood and these areas should be replanted to trees. For these reasons this report has been based on surveys made in hydraulics and forestry. The first efforts of the Authority should be directed towards carrying out the recommendations in these two fields, establishing a farm pond program and co-operating with the Department of Agriculture in spreading the adoption of good land use practices.

- A. H. R.

MUNICIPALITIES



RECOMMENDATIONS

RECOMMENDATIONS

STATED OR IMPLIED IN THIS REPORT

Forestry

1. That the Middle Maitland Forest be established and that it be expanded through a definite program of annual additions and planting until the total area of 5,118 acres is acquired and reforested. p. 31

2. That in areas in which it proves to be impossible to establish Authority Forest Tracts, due to the high cost of land, the Authority work out a form of agreement to be made with landowners which will ensure that tree cover be maintained and restored on these lands. p. 36

3. That a policy of aiding landowners to reforest marginal lands be implemented by the Authority. The Authority should provide a tree-planting machine which would be furnished to the landowner along with a tractor and a planting crew for a nominal sum. The Authority should further assist reforestation by subsidizing planting on land too rough, too steep and too wet for machine planting. p. 35

4. That the Authority encourage the establishment of natural regeneration in and close to existing woodlands by instructing landowners in methods of scarifying soil and breaking sod immediately preceding the dispersal of seed by parent trees. This should be done in early September for most species and early June for elm and soft maples. p. 39

5. That the Authority inaugurate a scheme to aid farmers in fencing their woodlots from cattle. This would enable regeneration to establish itself, restore the spongy cover of leaves and humus over the soil and improve the water-holding capacity of the soil itself. p. 44

6. That the Authority purchase a portable wood chipper which would be made available to farmers in the same way as the tree-planter. This would be especially useful on the Middle Maitland Watershed to clean up low-grade hardwood and weed trees in woodlots. The chips can be used in place of straw for cattle bedding and chicken litter and spread on the fields as humus. In some cases it may be possible to sell such chips to pulp companies. p. 36

Water

7. That model studies be made of the conduit section to provide more accurate flow data. p. 43

8. That Scheme B be carried out to provide the necessary flood relief. This work may be developed in two stages:
   (a) Lesser Channel Improvement
   (b) Listowel Dam and Reservoir. p. 51

9. That the spillway diversion to complete Scheme C be constructed, provided permission is granted by the Grand River Conservation Commission and the Grand Valley Conservation Authority. p. 55

10. That the Town of Listowel complete their sewer system and provide more adequate treatment for their effluent. p. 69

FORESTRY

CHAPTER 1

THE FOREST

1. Before Settlement

Good early descriptions of the original forests which covered the Middle Maitland Watershed are rare. The accounts which do exist mostly pertain to the settlement of the Huron Tract which lies south of the watershed except for small portions of Ellice, Logan and McKillop Townships. A picture of what conditions were like when the pioneers first began to move into this part of the country may be drawn from the descriptions contained in surveyors' notes, the scattered descriptions of the land north of the Huron Tract and from the small patches of bush which still remain.

One of the earliest descriptions of the region is contained in a report by Dr. Wm. Dunlop* who was Warden of the Woods and Forests for the Canada Company in 1827. Although the report is a description of the Canada Company tract, the Maitland River area is similar so that the report is applicable to this valley. "The summit level of the whole country is in the large swamp which, as will be seen by a glance at the maps, occupies so much of its centre. This swamp forms the reservoir of many of the branches of the large streams which water the great triangle of Upper Canada formed by the three Lakes". He describes four kinds of swamps - white cedar, black ash, spruce (which occurs only rarely, he says) and mixed swamps, usually of cedar and black ash. He says, "The black ash swale... wet in the spring and autumn but probably dry in midsummer.... has rich, deep soil" and that the ash is generally mixed with some soft maple and other trees. The main forest cover is described as mixed hardwood, with sugar maple the principal growth followed by beech, elm and basswood. Sometimes, but not often, there was more beech than maple. Hemlock predominated

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* Douglas Brymner. Report on Dominion Archives. 1898.

near the streams and interspersed all through were cherry, butternut, various species of oak and birch. Pine was rare.

The relation of the original forest to the soil is outlined by a writer in 1831:*

> "The nature of the soil may be invariably discovered by the description of the timber it bears. Thus, on what is called hard timbered land where the maple, beech, black birch, ash, cherry, lime, elm, oak, black walnut, butternut, hickory, plane and tulip tree, etc., are found, the soil consists of deep black loam. Where fir, hemlock and pine are inter-mixed in any considerable portion with other trees, clay predominates; but where they grow alone, which is generally on elevated situations, sand prevails. This also happens where oak and chestnut are the only trees."

The records kept by the early surveyors contain some information regarding the character of the primeval forest. Their notebooks included a running account of the composition of the forest cover along each survey line they ran. Excerpts from the original survey notes of Grey and Elma Townships give a fairly accurate picture of the forest within these townships. D. S. Donnelly, who surveyed the Township of Grey in 1853, described the forest cover on well drained sites as predominantly maple, beech, elm, basswood and hemlock. The swamplands of the township contained cedar, black ash, tamarack, soft maple and elm.

The forest cover in Elma Township† appears to have been similar to the forests of Grey; however, the hemlock mostly occurred on limestone ridges.

From the preceding descriptions and the farm woodlots of the present day, we may deduce that the Middle Maitland River had its source in the level land of Grey, Elma and Wallace Townships which were largely covered by swamp forests consisting chiefly of white elm, silver maple, black ash, cedar and tamarack. The remainder of the watershed was mainly covered

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* Hints on Emigration to Upper Canada (Huron Tract) 1831.

† John Grant, Survey Notebook of Elma Township. 1852-53.

with forest of the sugar maple - beech type, elm, basswood and hemlock.

2. Since Settlement

When settlement began on the watershed the forest stood in the way of all improvements and the task of removing it by primitive means must be accomplished before any new development could be undertaken. This naturally resulted in an antagonistic attitude towards the forest. This attitude, coupled with the idea that the supply of timber was inexhaustible, was so firmly established that it is only in recent years that it has begun to disappear.

Lumbering did not play a prominent part in the settlement of the watershed; this is partly because there was no great quantity of pine and partly because of the distance from markets.

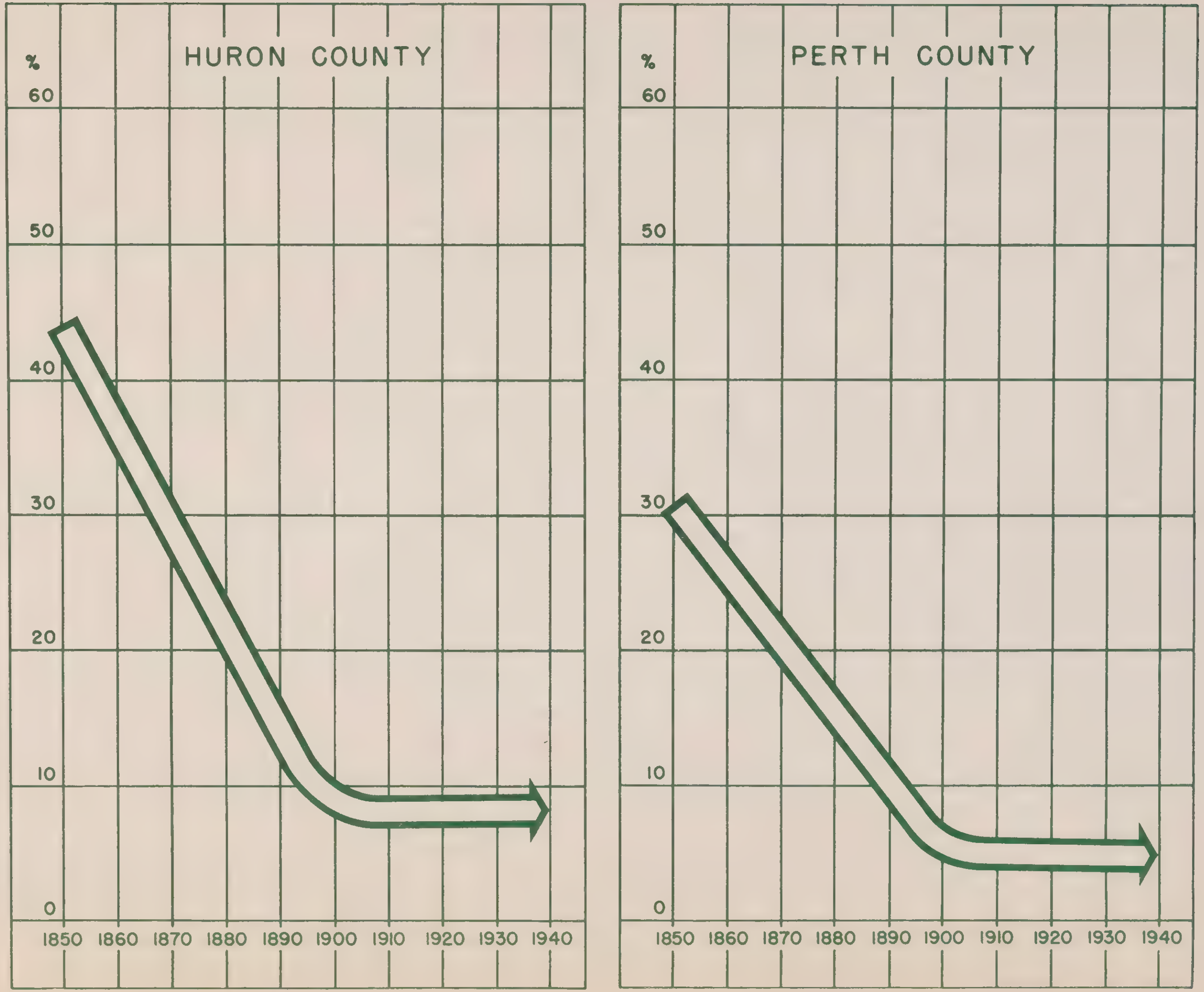
Most of the land is of high agricultural value and was largely covered with stands of hardwood, for which there was a limited market. When a new area was opened for settlement, the best land was taken first and the rough and swampy areas were avoided. Land was usually cleared first along the front of the farms. The land bordering the swamps was eventually settled, the swamps were partially drained so that the edges became dry enough for partial cultivation, and the forest was pushed back.

Today the centres of the swamps form the nuclei of the largest patches of woodland remaining in Southern Ontario; this is well exemplified by the large swamp extending across Elma Township west of Milverton and by the vast Ellice Swamp which lies south of the watershed.

Such swamps form natural surface water-storage areas and in many cases are the sources of headwater streams. These areas are productively low at the present time but there is no reason why they should not produce a profitable timber crop.

PER CENT WOODLAND ON OCCUPIED FARM LAND

CENSUS OF CANADA FIGURES



The comments of earlier writers with regard to land clearing and lumbering are of interest in tracing the gradual development of western Ontario:*

> "Too frequently is it the case that the person clearing land to make a farm, be he an old settler or a newly arrived, commits indiscriminate slaughter among the trees and making a clean sweep....destroying everything and leaving his dwelling unshaded and unsheltered for the next generation. Much of this absurdity, as far as the new settlers are concerned, must be attributed to the advice and assertions of the 'old inhabitants', who are in the habit of telling them 'Oh! it's of no use trying to save the trees, you can't do it, the wind will blow them all down.' Ask them if they have themselves tried the experiment and speak from experience, they will answer 'no' but they have been told so. We could show hundreds of instances of the folly of such declarations in trees which must have stood singly and alone for at least thirty or forty years although at least two hundred or three hundred years old at the time they were singled out for their large size and left standing as landmarks. Yet they have not been overturned and are still strong and healthy enjoying a green old age.
>
> "After a clearing had been made enabling the production of more than for personal requirements the question of marketing the surplus was a serious one.† Nowhere nearer than Dundas was there a market of any consequence and even then the difficulty was to obtain cash for produce as in those days nearly all transactions were made in trade because cash was not easily procured and there was very little of it in the country. There were also many difficulties in transporting the produce to market. The so-called roads were merely trails cut through the woods and in the spring and fall were practically impassable, but when winter came on, conditions for transportation became much better. Whenever swamps or low wet lands proved a hindrance the corduroy roads were brought into use. No drainage could be undertaken so logs were laid crosswise over the trails and covered with earth and this constituted the so-called corduroy road."

The rate of reduction of the forests was very rapid as is shown by the accompanying tables and graphs; for example in Elma Township the area of woodland on occupied farms dropped from 50 per cent in 1860 to 26 per cent in 1890 and 5 per cent in 1910. According to the Census of Canada the other townships show a similar drop. The chief value of these figures lies

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* W. H. Smith. Canada, Past, Present and Future. 1851.

† E. W. B. Snider. Waterloo County Forests and Primitive Economics. 6th Annual Report, Waterloo Historical Society. 1918.

WOODLAND IN PER CENT AND ACRES ON OCCUPIED FARMLAND

Township	Township Area In 1940	1850		1880		1890		1910		1920		1930		1940	
		Per Cent	Acres	Per Cent	Acres	Per Cent	Acres	Per Cent	Acres	Per Cent	Acres	Per Cent	Acres	Per Cent	Acres
Wawanosh E.	42,140			95.0	40,019	24.8	10,030	17.4	7,331	11.3	4,770	12.5	5,254	13.2	5,828
McKillop	52,768			35.5	18,768	13.2	6,966	5.6	2,971	4.9	2,570	4.9	2,557	4.7	2,414
Grey	64,689			51.1	33,091	24.5	15,837	10.2	6,622	7.9	5,129	8.7	5,624	7.7	5,007
Morris	55,856			60.1	33,590	22.6	12,675	16.8	9,355	8.4	4,672	9.5	5,333	5.3	5,208
Total	215,453			58.2	125,468	21.1	45,508	12.2	26,279	7.9	17,141	8.7	18,768	8.6	18,457
Ellice	52,387	21.7	11,355	25.7	13,419	17.2	9,010	6.3	3,296	4.1	2,152	4.3	2,268	4.4	2,318
Logan	53,895	15.8	8,528	34.4	18,587	14.7	7,928	6.3	3,394	3.6	1,962	4.5	2,453	4.0	2,171
Wallace	50,841			64.0	32,264	25.1	12,742	13.5	6,867	8.8	4,456	8.4	4,269	7.4	3,754
Elma	66,579			50.5	33,671	26.0	17,332	5.6	3,738	4.5	2,993	4.4	2,930	4.3	2,848
Mornington	50,281	44.2	22,113	47.4	28,858	19.0	9,530	9.9	4,461	6.5	3,296	5.5	2,770	4.7	2,362
Total	273,983		41,996	46.1	126,799	20.7	56,542	8.1	22,256	5.4	14,859	4.6	12,690	4.9	13,453
Maryborough	56,220	31.9	17,932	52.7	29,696	20.8	11,719	22.6	12,753	8.4	4,748	9.3	5,236	7.0	3,923
Total	56,220		17,932	52.7	29,696	20.8	11,719	22.6	12,753	8.4	4,748	9.3	5,236	7.0	3,923

in showing the rate at which the bush was cleared rather than the actual acreage of woods remaining at the given dates because the definition of woodland varies from person to person.

For example, one farmer or census taker might consider a certain cutover area to be pasture while another would call it woodland because considerable reproduction or young growth still remained, and this caused many discrepancies in the figures.

The actual measurement of the woodland area within the watershed made in 1952 shows a total of 12,747 acres of woodland or less than 8 per cent of the total area of the watershed.

CHAPTER 2

FOREST PRODUCTS

The forest industries in Southern Ontario passed through several phases prior to the beginning of settlement on the Middle Maitland Watershed in the fifties. Until 1826 the only persons authorized to cut timber on public lands were the contractors for the Royal Navy, or those holding licences from them. The inauguration of a system under which anyone was at liberty to cut timber on the ungranted land of the Ottawa lumber region on payment of a fixed scale of rates to the Crown did much to encourage the new industry in the Province. The production of masts and spars for export to Britain became a thriving industry in the thirties and forties, but dropped off noticeably by the mid-fifties, due to the Reciprocity Treaty with the United States in 1854, which made trade with the United States more profitable. The square timber trade commenced, no doubt, somewhat later than the mast trade and was carried on simultaneously with it from the thirties.

Although forest industries were well established in the Province by the time settlement commenced on the watershed, logging did not play an important role in the economy of the area. This may be attributed to the composition of the original forest which was predominantly hardwood, for which there was a limited market. The local pine, hemlock and cedar probably barely filled the requirements of the local settlers.

1. Saw Material

From 1800 on, the cutting of timber had been one of the most important domestic businesses in most parts of Southern Ontario. To convert logs into boards the first method used was pit-sawing. This was sometimes done on the bank of the river, as such procedure saved the necessity of digging a pit.

The more usual methods of pit-sawing appear to have been the digging of a pit or building of a platform

with a simple but firm and strongly constructed framework. In either case the framework was made the right height for one man to stand underneath, while the other man stood above on the platform or astride the log. This hard method of sawing timber was laborious and twenty-five boards were a heavy day's work for two men; the boards were nearly always one inch thick, with planks two inches, and the occasional flooring one and a half inches in thickness.

The first power saws were a direct development of the manually operated pit saw. These were called frame, upright or muley saws and consisted of a saw set vertically in a wooden frame and moved up and down by means of a crank connected to the shaft of the water wheel.

> "Wherever a settlement is formed in America a sawmill is very soon after, if not at the same time, erected. The number of sawmills in the British colonies are inconceivable to those who are not familiarized to the rising settlements of new countries.
>
> A sawmill is in fact a most important establishment. It not only forms a nucleus or centre to a settlement, but a first-rate sawmill, with two frames, will give employment to four first-rate, four second-rate and two third-rate sawyers, besides a measurer, a blacksmith and from thirty to forty men to prepare the timber required and for other requisite work connected with the establishment; twenty oxen and two horses are also necessary for hauling the timber required to streams and to other places. The boards, deals and scantlings sawed at these mills, excepting such as are required for the use of the neighbouring settlers, are rafted down the river for shipping. As fresh waters change the colour of the deals from their fresh white to a dark gray and, in the eyes of prejudice, depreciate their value, it becomes an object, but one that can only be attended to accasionally to carry them down in bateaux, scows or on timber rafts." *

A study of the Census of Canada returns of forest products of farms given in the table reveals the various trends and changes in the lumber industry fairly clearly.

From 1870 to 1890 much of the timber was squared and measured in cubic feet. In 1870 other products listed were firewood, staves, lathwood, tanbark, and masts

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* John McGregor, 1833. British America, Vol.II.

FOREST PRODUCTS OF FARMS - CENSUS OF CANADA FIGURES - HURON COUNTY

Product	Species	Unit	1870	1880	1890	1900	1910	1920	1930	1940
Pulpwood		Cords			50					10
Tanbark		"	4,497	6,383	3,106	168	34			
Lathwood		"	184	117	56					
Masts & Spars		Number	4	262	19,789	1				
Staves		M	689	1,120	1,437	1,410	370			
Fence Rails		Number						15,180	5,600	
Fence Posts		"			145,656	35,491	6,995	15,905	17,798	
Poles		"			82	413	1,913	83	135	
Railway Ties		"			4,278	21	1,200	35	2,400	
Square Timber	Ash	Cu. Ft.				3,820	790			
	Birch	" "				350				
	Elm	" "			143,138	34,604	29,695			
	Maple	" "				6,884	10,080			
	Oak	" "	28,707	40,403	5,270	713	1,100			
	Pine	" "	71,150	24,388	2,102	2,750	4,968			
	Others	" "				21,828	4,260			
	Total	Cu. Ft.	99,857	64,791	150,510	70,949	50,893			
Logs (Lumber)		Number						44,493	1,319M	
Logs, Softwood	Pine	Cu. Ft.	32,388	587,873	54,591	380M	116M			
	Others	" "	85,330	457,753	347,434	24M				
	Spruce	" "					8M			
Logs, Hardwood	Tamarack	" "	1,000	34,431	3,080					
	Oak	" "				53M	5M			
	Maple/Birch	" "	7,094	24,295	215,151					
	Elm	" "	223,304	348,622		2,824M	1,240M			
	Black Walnut	" "	100	817	3,550					
	Butternut	" "	400							
	Hickory	" "	1,066	3,319	1,200	113M	1M			
	Others	" "	538,449	390,895	72,278	3,833M	1,564M			
	Hemlock	" "				1,599M	405M			
	Total	Cu. Ft.	899,131	1,848,005	134,728	8,826M	3,339M			
Fuelwood		Cords	188,319	233,971	155,324	136,036	92,009	119,764	72,336	57,265
Shingles		M			2,769					
Other Products		Value $						1,969	189	40,887

FOREST PRODUCTS OF FARMS - CENSUS OF CANADA FIGURES - PERTH COUNTY

Product	Species	Unit	1870	1880	1890	1900	1910	1920	1930	1940
Pulpwood		Cords								10
Tanbark		"	2,556	2,533	1,591	12	11			
Lathwood		"	184	108	45					
Masts & Spars		Number	30	507						
Staves		M	405	1,921	35	9	74			
Fence Rails		Number						10,223	29,769	
Fence Posts		"			45,845	4,965	580	5,815	5,149	
Poles		"					6	5	49	
Railway Ties		"			646				100	
Square Timber	Ash	Cu. Ft.				20,669	1,800			
	Birch	" "				886	1,000			
	Elm	" "			103,137	113,528	8,742			
	Maple	" "				36,224	39,478			
	Oak	" "	8,933	55,243	2,100	1,830				
	Pine	" "	16,241	47,687	52,815	2,350				
	Others	" "				43,060	8,474			
	Total	Cu. Ft.	25,174	102,930	158,052	218,547	59,494			
Logs (Lumber)		Number						17,147	462M	
Logs, Softwood	Pine	Cu. Ft.	61,112	154,017	15,423	162M				
	Others	" "	35,187	197,527	51,180					
	Spruce	" "				5M	3M			
Logs, Hardwood	Tamarack	" "	7,388	6,530						
	Oak	" "				66M	75M			
	Maple/Birch	" "	5,806	7,611	2,505					
	Elm	" "	103,902	174,632		2,209M	1,647M			
	Black Walnut	" "	160	525						
	Butternut	" "		131						
	Hickory	" "	530	100	45	5M	1M			
	Others	" "	170,342	330,998	40,375	611M	284M			
	Hemlock	" "				200M	32M			
	Total	Cu. Ft.	384,517	872,071	109,528	3,258	2,042			
Fuelwood		Cords	115,030	134,429	95,499	96,568	44,470	56,244	35,952	27,127
Other Products		Value $						772	740	10,590

and spars. In 1890 the peak production of nearly all items was reached and squared elm alone in Huron County ran to over 143,138 cubic feet. Fence posts and telephone poles were added to the list of products, as were railway ties. In the census years of 1900 and 1910 square timber was still recorded in cubic feet and logs were measured in board feet; staves, lathwood, masts and spars and tanbark disappeared from production.

In 1920 no square timber is shown and logs are not even separated by species. The returns of the latest census covering the year 1940 name only one forest product and the rest are all listed together as "others" valued at so many dollars. The one product which has persisted throughout the records is firewood which in Huron County has dropped from a peak of 233,971 cords in 1880 to 57,265 cords in 1940.

One or two interesting observations with regard to individual species may also be made. Tamarack was listed regularly until 1890, being the third most important species with 34,431 cubic feet cut in 1880; after 1890 it no longer appears, due to the depredations of the larch sawfly which almost wiped it out at this time.

2. Shingle-Making

In the history of roofing used on the Middle Maitland Watershed it is found that the first covering for human habitation on the river was the Indian elm-bark lashed roof. The first type of roof used by the early settlers was made of "scoops" which were flattened logs, usually cedar, six inches thick with one face scooped out to a depth of one to one and a half inches. These ran from the peak of the roof to the eaves, being placed alternately so that one scoop had the scoop side up and the next one the scoop side down, the edges overlapping the two scoops below.

The second type of covering was a rude type of shingle called a "shake". These were made with an axe

or frow and were cut from pine or cedar three or more feet in length. Although not shaped they were a great improvement over the early types of covering.

Very early in the history of settlement, however, hand-made shingles were introduced. The shingle-maker would saw the logs into short lengths or bolts and split them with a frow to the right thickness. The shingle was then fastened by one end in a device called a shingle horse and by means of a heavy drawknife the shingle was tapered to the edge. This method was rapid and it has been said that a good shingle-maker would turn out from eighty to a hundred of these hand-made shingles an hour.

Up to the seventies and even later the shingle-maker continued to use drawknife and frow, but gradually in the seventies the generation of draftsmen died out and the shingle mill, where shingles were sawn, became the general source of supply.

3, Fuel and Ties

During the earliest days of settlement on the Middle Maitland, wood was the sole source of fuel supply. All species were used for this purpose, including oak and maple - though these were furniture woods as well. With the inception of the railway and steam-driven factories, the forests of the area were ruthlessly cut to feed industry.

In the very early days of the steamship, 1832, the Honourable Adam Fergusson writes:-

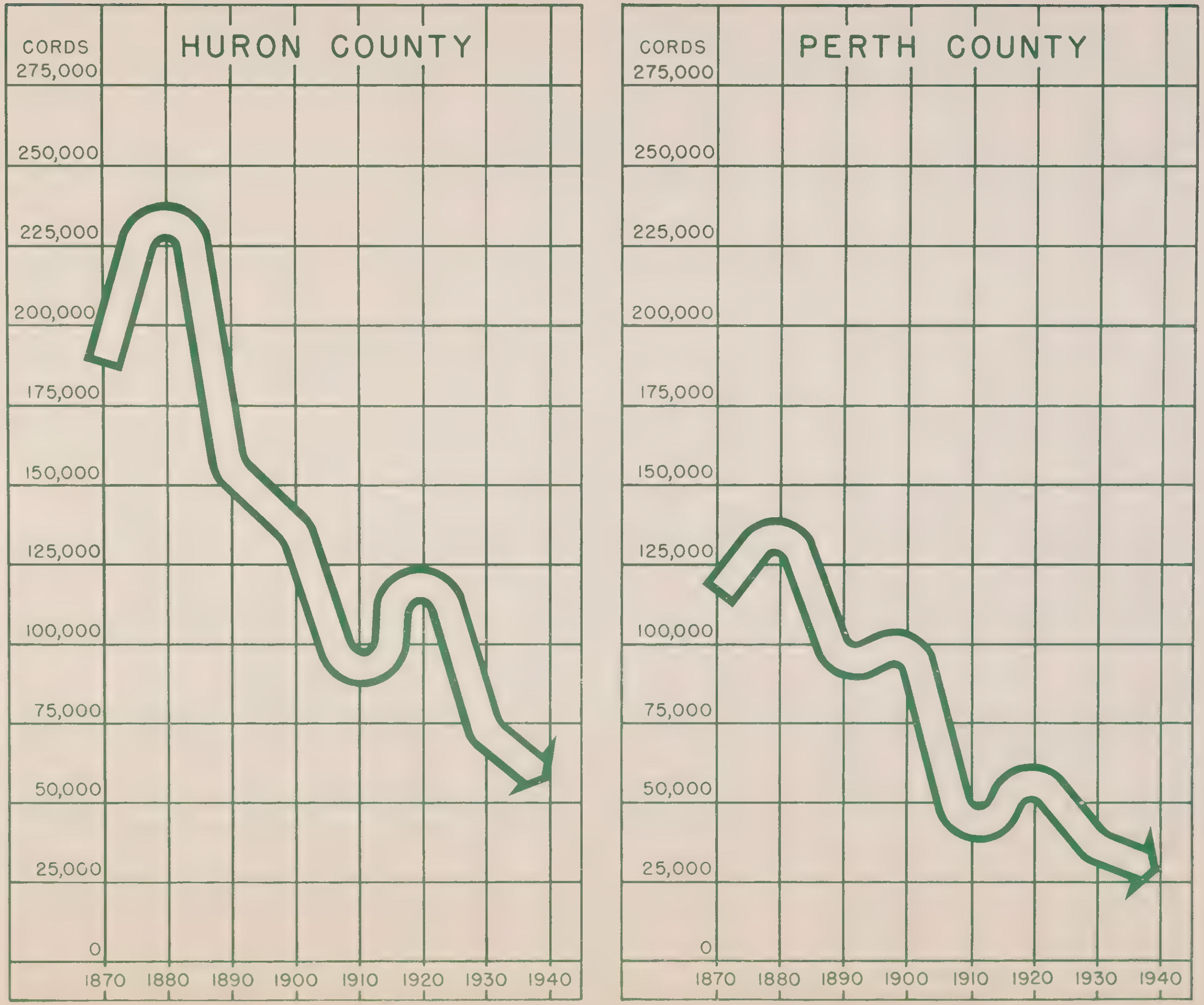
> "Wood is furnished upon the St. Lawrence for one dollar, or five shillings per cord while upon the Hudson it now costs three times as much. A man may prepare two cords a day, but it is severe work, and the price, which is one dollar per cord, will do little more than compensate maintenance and labour - and an ordinary steamboat consumes fifty or sixty cords or about 7,000 cubic feet each trip (from Montreal to Quebec)."

The price of cordwood in 1825 was quoted at $2 a cord.

With the completion of the Great Western between Toronto and London in 1853, locomotive requirements took large quantities of the best body hardwood, chiefly beech and maple.

FUELWOOD PRODUCTION

CENSUS OF CANADA FIGURES



"Coal at that time was not to be had and the result was that hardwood was gradually becoming of some value. For cordwood the settlers usually realized from $2.50 to $3.00 per cord, delivered at the various stations along the railway line. Railway facilities also stimulated the lumber industry."*

4. Road Materials and Fencing

In the early days the making of corduroy roads furnished another important wood use. The Indian trails had followed the ridges and natural conformation of the country, but when the "T-square" roads had been laid out in government offices they followed the arbitrary lot and concession lines regardless of natural contours. Many of these roads were built through swamps and in these places corduroy construction was used. Many corduroy bridges and culverts were also placed over the river and its tributary streams.

The building of plank roads - a form of highway in which the planks were laid crosswise and side by side - was done in several parts of the Province.

Much wood was also used for fencing and for this cedar from the swamps was most common. The troublesome pine stump also was used for this purpose in many parts of the Province, although in very early times it seems that it was left in the field. Around 1900 the wire fence came into use generally and thereafter a fence post industry was developed. These were cut as a rule to a standard length of eight feet, while the diameter varied greatly.

5. Woodworking and Planing Mills

During the early years of settlement in the rural districts and communities, house trim for exterior and interior use was made by the same man who constructed the frame of the house. The custom up to the fifties at least was for the carpenter to board with the family the winter before the new frame house was to be built and work all his

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* E. W. B. Snider, Waterloo County Forests and Primitive Economics. 6th Annual Report of the Waterloo Historical Society 1918.

timber into shape by hand, both for exterior and interior use.

The early carpenter also made door and window frames and all interior trim of the house by hand and for all these products pine was the usual type of timber chosen. It would seem that doorsteps were one of the very few things for which oak was used in house building, at least up to the sixties.

Generally, as time passed, the building trades became more differentiated and more craftsmen settled on the watershed.

After the appearance of the planing mill in the fifties the end of the hand-made door and window frame was foreshadowed and much of the general carpenter's work was taken over by the mill or factory. By the 1860's the planing mill business was well under way.

6. Wooden Implements and Vehicles

(a) Early Tools

From the very early days hickory was preferred for the making of axe-helves or handles, while for beams or ox-yokes beech was used extensively and for the loop ironwood would have been selected. Spike handles were made of rock elm, white ash, hickory or ironwood; the beetle-head (a mallet used for pounding hemp and flax) was also made of ash, elm, hickory or ironwood. The hardwoods growing on the watershed were used almost entirely for making handles of implements, whereas pine was preferred for all building operations when it could be obtained.

(b) Vehicles

From early times the making of vehicles progressed and a carriage works operated for many years. Carts, wagons, sleighs and hay and woodracks were built by the farmers. In the building of carts and wagons, whiffle-trees, wagon-tongues and binding poles were made of rock elm, white ash, hickory and ironwood, as were also sleigh-runners and hay and wood racks.

Usually the wheels or runners of these conveyances were bound with iron, although the use of metal was limited in early days since the supply had to be imported by water.

7. Indirect Products and By-Products

The three indirect products of greatest importance were potash, maple sugar and tanbark. Maple sugar furnished the staple sugar for the pioneer, cane sugar not having been procurable at that time; lye or potash was used domestically in making soft soap - almost the universal soap; tanbark was utilized by the shoemaker in dressing leather.

(a) Potash

The ashery played an important role in the drama of pioneering life. Besides communal asheries the individual ash house and the ash barrel on a platform for leaching were a characteristic of each farm in the days before the soap factory.

> "Only from the sale of potash (exported to Great Britain and the United States for the dyeing of textiles) was there money for all other requisites. The potash was laboriously produced, men, women and children sharing in the heavy work. No less than 60 large maple trees were required for a barrel of 650 to 700 pounds of potash. The ashes of the burnt wood were leached in wedge-shaped wooden troughs and this liquid was then boiled down and cooled in huge vessels or coolers where the lye solidified. Two coolers would fill a barrel. If the settler marketed this on his own, 'toting it out' to the nearest buyer for ready cash, he might get only $8.50 to $9.00, but if he could wait and accept a down payment from the traders and shippers who teamed and hauled at a season of their own convenience, he might get $10 or $12 with a possible second payment after marketing it at Montreal where a barrel might bring $30, less of course commission, risk and portage costs. The need for this pitifully hard-won money led to clearing of more land than could be cropped and not infrequently to concealing for years the fact that the holding itself might not be profitable or capable of sustaining the settlers from the growth of its poor soil."*

(b) Maple Sugar

The table shows the census figures for maple products in Huron County. It is interesting to note that

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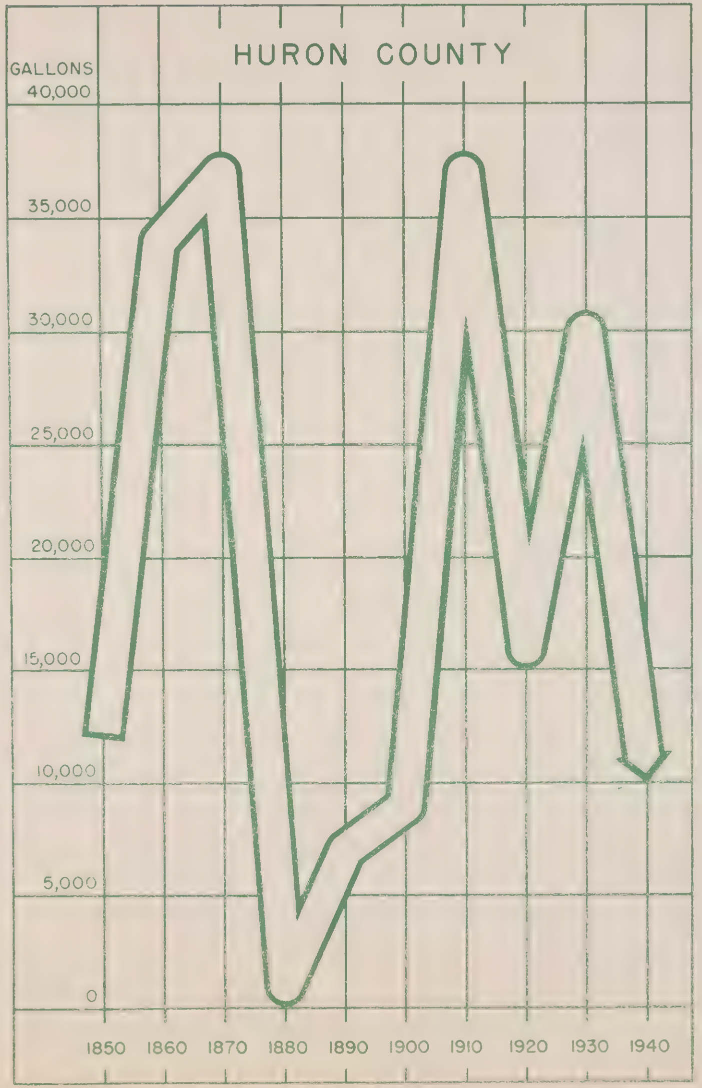
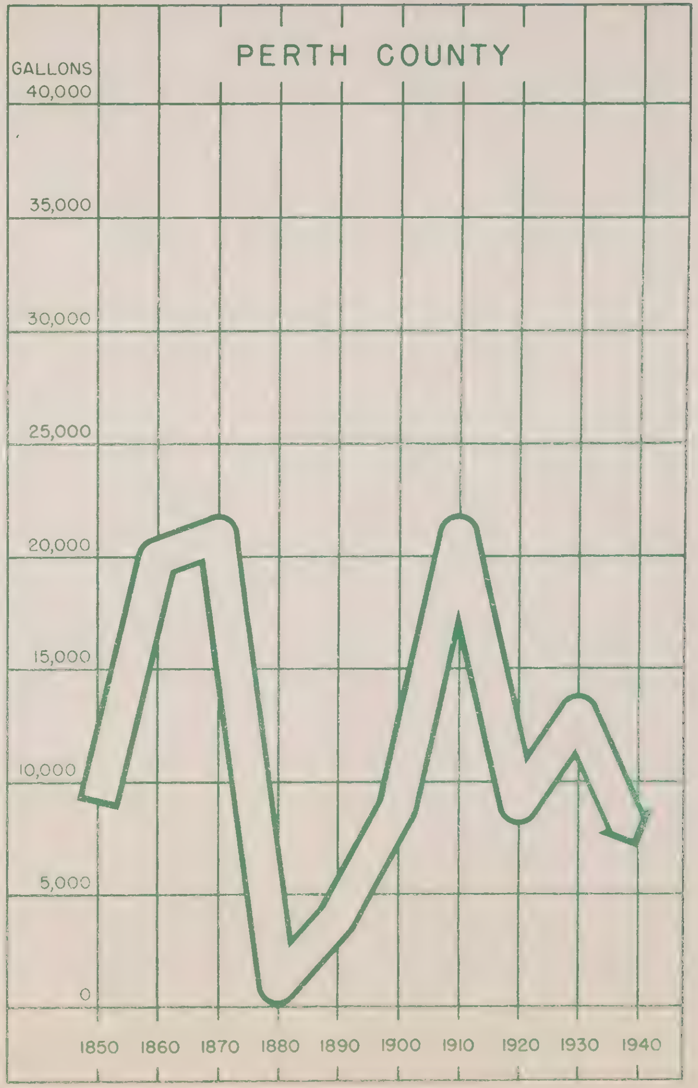
* Gillies Bros. Ltd., 1942. A Hundred Years A-Fellin', 1842 - 1942.

MAPLE PRODUCTS

CENSUS OF CANADA FIGURES





CENSUS OF CANADA FIGURES

MAPLE PRODUCTS

HURON COUNTY

1850	1860	1870	1880	1890	1900	1910		1920		1930		1940	
Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Gals.	Lbs.	Gals.	Lbs.	Gals.	Lbs.	Gals.
120,268	345,336	375,607	19,974	75,487	93,417	13,210	36,129	1,639	16,254	1,105	30,286	650	10,824
Gals.	Gals.	Gals.	Gals.	Gals.	Gals.		Gals.		Gals.		Gals.		Gals.
12,027	34,534	37,561	1,974	7,549	9,342		37,450		16,418		30,397		10,889

PERTH COUNTY

1850	1860	1870	1880	1890	1900	1910		1920		1930		1940	
Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Gals.	Lbs.	Gals.	Lbs.	Gals.	Lbs.	Gals.
99,125	207,286	201,224	9,037	48,639	92,662	803	21,269	209	9,503	140	13,627	810	6,343
Gals.	Gals.	Gals.	Gals.	Gals.	Gals.		Gals.		Gals.		Gals.		Gals.
9,912	20,729	20,122	904	4,864	9,266		21,349		9,524		13,641		6,424

In the second portion of each table, pounds of sugar have been converted to their equivalent in gallons of syrup for purposes of comparison.

up to 1910 production is all recorded as pounds of sugar; from 1910 on both pounds of sugar and gallons of syrup were shown, indicating the change from a pioneer necessity to the modern luxury. For purposes of comparison the sugar figures have been converted to their syrup equivalents and from these, shown in the second table, it will be seen that production for Huron County dropped steadily from the peak of nearly 143,862 gallons in 1900 to 11,825 in 1940.

CHAPTER 3

PRESENT WOODLAND CONDITIONS

The Middle Maitland Watershed lies entirely within the Huron-Ontario section of the Great Lakes - St. Lawrence Forest Region.* This section is characterized by a forest in which maple and beech are the dominant species on dry, well drained sites. With these are basswood, white elm, white ash, some yellow birch and red maple and red, white and bur oak. Small groups of hemlock and white pine occur within the association as well as a scattered distribution of large-toothed aspen, bitternut hickory, butternut, ironwood, black cherry and blue beech; slippery and rock elm, black ash, white cedar and tamarack are found locally on specialized sites such as bottomlands and swamps. Trembling aspen occurs on the poorly drained soils where the stands have been cut and burned in the past.

The almost level till plain which occupies most of the central portion of the watershed contained many large hardwood swamps, composed chiefly of black ash, elm and silver maple. Most of this has been cleared for agricultural purposes, but the remaining woodlots still contain a portion of these types. The large swamps in the southern portion of Elma Township supported a mixed forest of conifers and hardwoods; however, repeated fires, clearing and grazing have reduced these to aspen and scrub willow areas.

West of the till plain the area is broken by moraines, spillways and kame moraines which created better natural drainage and the forest was predominantly beech - sugar maple type which is also reflected by the remaining woodlots. Along the south-east boundary of the watershed the Milverton moraine forms a low ridge of well drained soils which

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* W.E.D. Halliday. A Forest Classification for Canada. 1937.

support stands of hard maple and beech. East of the moraine, the till plain contained several extensive black ash, white cedar and tamarack swamps. This area, which is drained by Boyle Creek, has been extensively cleared and drained and the only tree cover which remains in this area is young poplar and elm - silver maple stands.

1. Survey Methods

Each member of the Forestry party was provided with aerial photographs which were on a scale of 1,000 feet to the inch and each photograph covered an area of approximately 1,000 acres, usually a block lying between two adjacent concession roads and two adjacent side roads. Mapping was done in the field directly on the photographs.

Every area of woodland, brushland, marsh, swamp and rough land down to one acre in area was examined and notes made describing it. In the case of woodlots and plantations, detailed notes were made of their condition. Overgrazed woodlots and woodlots with very scattered trees which could be restored were classified as woodland. In short, where doubt existed as to whether an area should be classified as woodland or not, woodland was given the benefit of the doubt.

All woodlots were grouped according to the following classification:

Diameter Breast High	Hardwood	Mixedwood	Coniferous
Virgin	H-1	M-1	C-1
Over 18 inches	H-2	M-2	C-2
10 - 18 inches	H-3	M-3	C-3
4 - 10 inches	H-4	M-4	C-4
Under 4 inches	H-5	M-5	C-5

In this classification the term "hardwood" is used to denote all broad-leaved trees irrespective of whether the wood is physically hard or not. A hardwood type is one

in which 80 per cent or more of the stand is composed of hardwood trees, a coniferous type is one in which 80 per cent of the stand is composed of coniferous trees and a mixedwood stand embraces all others.

Stands were also recorded according to forest cover types.* (Refer to the table, the description of forest cover types and the forestry map folded at the end of this report.)

The forestry map is on a scale of one mile to the inch and covers the whole of the Middle Maitland Watershed. It shows all existing woodland, county forests, scrubland, and land recommended for acquisition by the Authority.

A forest cover type may be either temporary or permanent; for example, the present stand may be aspen which has seeded in the area following fire. Aspen seed is light like dandelion seed and is carried easily by the wind, thus it quickly covers large areas; also it is not exacting in its soil requirements and may be the only species which will grow under the soil conditions existing at the time. The fact of its growing and dropping its leaves on the ground gradually improves the condition of the soil so that more exacting species can grow. In addition its light shade frequently provides the correct light conditions for better species to get a start. As it is a short-lived tree, it will die early and the other species will dominate the area. This succession may be carried through two or more stages until the species best suited to the area or best able to maintain itself on the area takes over; this is called the forest type or climax type, as distinguished from the forest cover type which is the type occupying the ground at the present time. The most common forest type on the Middle Maitland Watershed is aspen which has established itself mostly

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* Forest Cover Types of the Eastern United States. Report of the Committee on Forest Types, Society of American Foresters. 1940.

as a pioneer species on cut-over and neglected pasture throughout the watershed.

No classification of forest cover types has been made in Canada for Southern Ontario, so the system used is a slightly modified form of that drawn up by the Society of American Foresters, which covers the whole of the eastern United States; consequently there are many types in their classification which do not enter Canada and this accounts for the gaps in the numerical listing of types occurring in the Middle Maitland Watershed. The forest cover types may be listed as follows:-

Number	Name
4	Aspen
11	Hemlock
13	Sugar maple - basswood
14	Sugar maple
14a	Black cherry
24	White cedar
26	Black ash - white elm - red maple
57	Beech - sugar maple
60	Silver maple - white elm
60a	White elm
88	Willow

Type 4 - Aspen

Aspen is a pioneer type coming in after fire or overgrazing. Though it avoids the wettest swamps it grows on soils that are wet throughout a good part of the year, as well as on dry soils. Its associates may be white elm, paper birch, red cherry and balsam poplar, with occasionally large-toothed aspen and green ash. It has the greatest acreage of any cover type on the watershed, forming 28.7 per cent of the woodland. Extensive stands of this cover type occur on the swampy lands in the southern portion of Elma Township.

Sugar maple stands originally covered a large percentage of the upland areas of the watershed. As they occurred on the most desirable agricultural soils, a large portion of the original forest has been cleared. However, the remaining stands are the second most abundant cover type in the watershed.

Type 11 - Hemlock

This type occurs in widely scattered stands in cool locations, moist valleys and north slopes, frequently as an associate species in the sugar maple - beech type. Its associates are beech, sugar maple, yellow birch, basswood, red maple, black cherry, white ash, white pine, paper birch. The original forests of the watershed contained a large proportion of hemlock; however, the local demand for softwood lumber by the original settlers depleted these stands until now there are only 33 acres of this type in the watershed.

Type 13 - Sugar Maple - Basswood

Although the distribution of this type is limited on the watershed, this cover type is fairly important on loamy upland soils. Its associates are white elm, green ash, yellow birch, white pine with ironwood and blue beech as subordinates. As basswood is a desirable lumber, this type is often reduced to a sugar maple type by the removal of basswood saw logs. Only 48 acres of Type 13 were mapped on the watershed.

Type 14 - Sugar Maple

This type undoubtedly originally covered a considerable part of the well drained areas in the watershed. Since it occupied much of the most desirable agricultural lands, a large portion of it has been cleared; however, it is still the second most abundant cover type in the watershed. With the hard maple, smaller proportions of other species such as yellow birch, white ash, red and white oak may be present. 2,622 acres of this type were mapped. Its area may have been increased in recent years by the removal of beech for firewood from Type 57.

Type 14a - Black Cherry

This type is not common but second-growth stands occur, usually on fertile, moist, well drained soils, frequently those formerly occupied by hemlock. Its associates may be sugar maple, red oak, red maple, white ash, basswood, white elm and hemlock. Only 13 acres were found on the watershed.

A large proportion of the woodland which remains in the Middle Maitland Watershed is located in imperfectly drained areas. These stands of swamp hardwoods contain varying amounts of white elm, soft maple, black ash and aspen.

Aspen is one of the first species which often follows clear-cutting, fire or over-grazing. Stands of aspen occur throughout the watershed on a wide range of sites which vary from wet to excessively drained. This is the most common cover type in the Middle Maitland Watershed.

Most of the hardwood stands which occur on moist to wet sites are in need of woodlot management. This stand is in need of a sanitation thinning to remove dead, diseased and crooked trees and excessive coppice growth.

Type 24 - White Cedar

The associates of this type are tamarack, yellow birch, black ash, red maple, white pine and hemlock. It occurs on sites of slow drainage which are not strongly acid, including muck soils, and is also present on poor pasture land and bottomland. It forms only 2.3 per cent of the woodland, chiefly in Morris Township.

Type 26 - Black Ash - White Elm - Red Maple

This type originally occupied much of the moist to wet soils in swamps, gullies and small depressions. The type still occupies 1,302 acres or over 10 per cent of the woodland on the watershed. Its associates are balsam poplar, yellow birch, with sometimes white pine, tamarack, white cedar and basswood.

Type 57 - Beech - Sugar Maple

This is regarded as the typical association of the climax with red maple, white oak, hemlock, white elm, basswood, shagbark hickory and black cherry. This type was undoubtedly very extensive on the well-drained land in the Middle Maitland Watershed, but, because it occupied the best land, its area has been tremendously depleted. It still comprises over 10.5 per cent of the remaining woodland.

Type 60 - Silver Maple - White Elm

This is one of the most characteristic cover types of poorly drained soils unsuitable for general farming unless completely and adequately underdrained; for this reason it and the similar cover type 60a, white elm, has survived better than forest cover types on better drained land. Associated species are red maple, slippery elm, cottonwood, white, red and green ash, bur oak and butternut hickory. This type represents 12.4 per cent of the woodland of the watershed.

Type 60a - White Elm

Type 60a is very similar to the silver maple - white elm Type 60, but is found on drier sites as well as

FOREST COVER TYPES

Township	No. of Woodlots	Woodland Area (Acres)	4	11	13	14	14a	24	26	57	60	60a	88
Ellice	4	62	30									32	
Elma	216	3,627	989	8	25	574		12	491	426	654	443	5
Grey	178	3,759	1,275		17	773		63	487	352	463	321	8
Logan	5	84	44									40	
Maryborough	20	341	5			97		19	21	124	26	49	
McKillop	16	609	589			20							
Mornington	29	533	119			60			35	52	144	123	
Morris	101	2,633	504			591	13	204	161	239	270	651	
Wallace	53	1,028	99	25	6	507			107	128	40	116	
Wawanosh E.	4	71	12									59	
Totals	626	12,747	3,666	33	48	2,622	13	298	1,302	1,321	1,597	1,834	13
Per Cent			28.8	0.3	0.4	20.6	0.1	2.3	10.2	10.5	12.4	14.3	0.1
Rank by Area Occupied			1	9	8	2	11	7	6	5	4	3	10

swamps and swales; its associates are the same. It is not listed in the American classification but has been introduced here because of its frequent occurrence in Southern Ontario. It comprises over 14.3 per cent of the woodland. These two cover types make up 26.7 per cent of the total woods in the watershed.

Type 88 - Willow

Several species are included in this type, but the commonest is black willow. It occurs on wet sites on the margin of kettle lakes, and includes 13 acres on the watershed.

The large forestry map shows the distribution of all types throughout the watershed and from it the following observations may be made.

(a) Aspen is the most abundant cover type on the watershed. It occurs mainly in areas which have been found to be too wet for agricultural purposes. (It is the chief residual type following cutting and pasturing.) The type now forms over one quarter of the woodland.

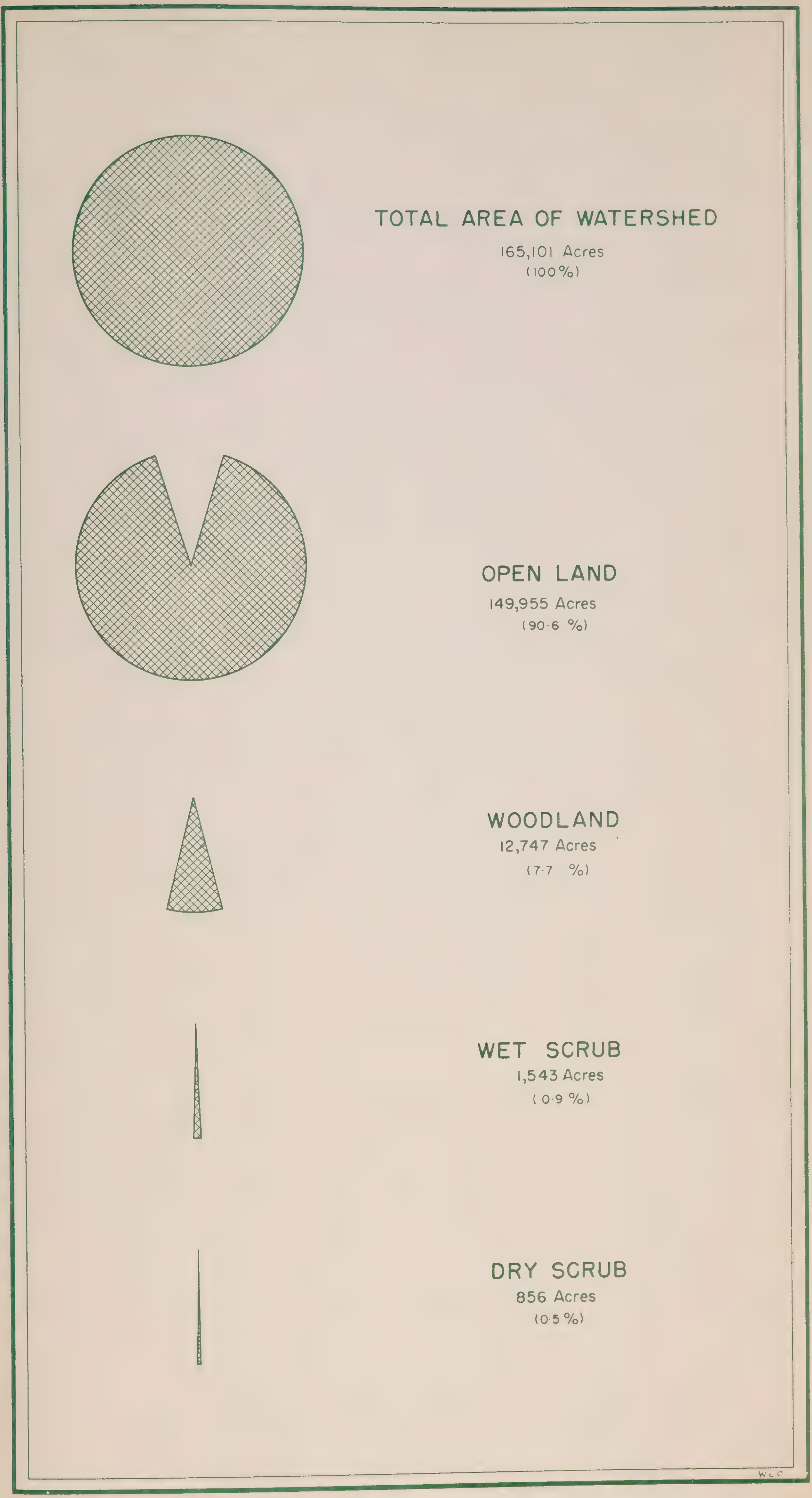
(b) Sugar maple and beech - sugar maple predominate on the well drained wooded sites in the watershed. The combined acreage of these types totals 31 per cent of the wooded area.

(c) The wet-site hardwoods, such as elm, silver maple - elm and black ash - white elm - red maple occupy a combined area of 4,752 acres or 37.2 per cent of the woodland in the watershed.

(d) White cedar, which originally was fairly extensive, has been severely overcut and pastured and almost eliminated. The remaining stands are mostly located in Morris Township.

2. Present Conditions

The results of the forest survey are summarized graphically in the accompanying table entitled "Woodland Conditions by Townships".



LAND CLASSIFICATION – TOTAL WATERSHED

Woodland within the watershed comprises 12,747 acres which is 7.7 per cent of the total area of 165,101 acres. The conifers occurring in the watershed are white cedar, tamarack, balsam fir, white pine, white spruce and hemlock. White pine is rare and scattered along the valleys of the stream. Hemlock is found mixed with hardwoods and white cedar, balsam fir and tamarack are present in the swamps. There is no doubt that conifers formed a larger part of the woodlands than they do today, especially hemlock which was distributed throughout the watershed in the original forests. The depletion of these stands of softwoods is due to the desirability of the lumber they furnished and recurrent fires have destroyed them while more fire-resistant species, such as some of the hardwoods, have remained. The clearing of many of the softwood swamps for agriculture further depleted the swamp softwood stands. The situation at present is that of the 12,747 acres of woodland on the watershed 91. per cent is classed as pure hardwood, 7.8 per cent as mixedwood and 0.4 per cent as pure conifers. In the 91 per cent classified as hardwoods 5.9 per cent is over 18 inches in diameter at breast height, 28.7 per cent is 10 to 18 inches, 46.9 per cent is 4 to 10 inches and 10.3 per cent is young growth under 4 inches in diameter at breast height.

In the mixedwood classes comprising 7.8 per cent of the woodland, 2.5 per cent is 10 to 18 inches in diameter at breast height, 5.5 per cent is 4 to 10 inches and 0.1 per cent is under 4 inches diameter. In the coniferous woods 0.1 per cent is 10 to 18 inches diameter, 0.1 per cent is 4 to 10 inches and 0.2 per cent is young growth under 4 inches diameter at breast height.

For the whole area the percentage of even-aged stands is somewhat less than the uneven-aged, the figures being 43.0 per cent of the former and 57 per cent of the latter.

WOODLAND CONDITIONS BY TOWNSHIPS

1952

Grazing in farm woodlots is a serious problem inthe watershed, the percentage of grazed woodland being 61.7 per cent for the whole watershed. Grazing, as is well known, is detrimental to the proper development of any woodland area. The number of cattle and the size of the woodlot have a direct relationship to the damage which is done. For example, a large woodlot is not as seriously affected by a few head of cattle as a small one, but on most farms the woodlot is small and is seriously damaged by large herds. Grazing in a woodlot destroys young growth; open areas appear and become covered with grass, which means that the maintenance of the forest floor, which is so important to the health of the stand, is interfered with and there is less likelihood of a renewing of the stand by reseeding from old trees. These in turn become stag-headed and are easily preyed upon by fungus and disease.

Fire is a serious factor menacing any woodlands, and all landowners should have a knowledge of its effects. It is not necessary to burn a tree to kill it; merely raising the temperature of the growing layer inside the bark to 150 degrees Fahrenheit will do the job, and this is frequently what happens.

Due to the custom of grazing in the woodlots some stands have become open and require some planting. Of the areas examined 49.6 per cent are devoid of natural regeneration and 49.1 per cent require some planting to bring them back to fully stocked stands. Cutting in woodlots and clean-cutting of whole areas has been carried on persistently. The fact that both counties in the watershed now have diameter limits has not stopped this practice of clear-cutting completely, because an owner may cut anything for his own use.

WOODLAND CLASS (ACRES)

Township	No. of Woodlots	Woodland Area	Woodland Class														
			H1	H2	H3	H4	H5	M1	M2	M3	M4	M5	C1	C2	C3	C4	C5
Ellice	4	62			17	15	30										
Elma	216	3,627		71	869	2,094	394			110	77				12		
Grey	178	3,759		76	1,098	1,985	378			55	167						
Logan	5	84			10	62	12										
Maryborough	20	341		6	34	282					19						
McKillop	16	609				156	453										
Mornington	29	533		9	239	269				16							
Morris	101	2,633		382	917	783	29			42	440					12	28
Wallace	53	1,028		218	466	270	21			53							
Wawanosh E.	4	71				59						12					
Total	626	12,747		762	3,650	5,975	1,317			276	703	12			12	12	28
			Total Hardwood 11,704					Total Mixedwood 991					Total Softwood 52				
Per Cent				5.9	28.7	46.9	10.3			2.2	5.5	0.1			0.1	0.1	0.2
			Total Hardwood 91.8					Total Mixedwood 7.8					Total Softwood 0.4				

WOODLAND CONDITION (ACRES)

Township	No. of Woodlots	Woodland Area	Aged		Grazed		Fenced		Reproduction			
			Even	Uneven	Yes	No	Yes	No	A	B	C	D
Ellice	4	62	30	32	30	32	7	55			15	47
Elma	216	3,627	1,645	1,982	2,319	1,308	508	3,119	47	583	1,183	1,814
Grey	178	3,759	1,303	2,456	2,389	1,370	291	3,468	82	450	1,232	1,995
Logan	5	84	57	27	44	40		84				84
Maryborough	20	341	159	182	175	166	58	283	23	70	123	125
McKillop	16	609	467	142	609		9	600			46	563
Mornington	29	533	263	270	445	88	81	452		57	199	277
Morris	101	2,633	945	1,688	1,070	1,563	223	2,410		201	1,261	1,171
Wallace	53	1,028	599	429	786	242	174	854	13	193	643	179
Wawanosh E.	4	71	12	59		71		71				71
Total	626	12,747	5,480	7,267	7,867	4,880	1,351	11,396	165	1,554	4,702	6,326
Per Cent			43.0	57.0	61.7	38.3	10.6	89.4	1.3	12.2	36.9	49.6

CHAPTER 4

CONSERVATION MEASURES IN PROGRESS

The soils most commonly used in Southern Ontario for plantation purposes are of a light sandy nature, and well drained. As this type of soil is practically non-existent in the Middle Maitland Watershed, interest in private planting has lagged. Although the absence of these soils limits the use of certain species of pine as a planting stock, many species which thrive on wetter, heavier clay soils may be substituted.

For forestry purposes the Department of Lands and Forests has divided Southern Ontario into Forest Districts which are subdivided into zones. Each zone has its Zone Forester and assistant, whose duty it is to give advice and assistance to private individuals, municipalities and Authorities on the management of their woodlands and the establishment of plantations. The office covering the zone in which Huron and Perth Counties are located is in Stratford.

St. Williams Nursery in Norfolk County, which is the closest forest tree nursery to the Middle Maitland Watershed, has served as the largest production and distribution centre for trees ever since its establishment 45 years ago.

1. Private Planting

Reforestation, combined with the protection of natural woodlots, is essential if farmers are to have sufficient woodland to supply the local community with fuelwood, fence posts and poles, and to have a few saw-logs for sale which will provide a cash crop at times when the prices of other farm products are depressed. Reforestation of certain areas will not only mean that the land will be producing a crop where little or nothing of value is growing now, but it will also provide adequate protection for the soil from wind

and water erosion and will retard run-off of water from melting snow and rain, thus making for a more even stream flow throughout the year.

The free distribution of trees for reforestation and windbreak planting was first begun in 1905, and for 19 years any quantity could be obtained free for this purpose. In 1924 it was decided to supply free trees up to a maximum of 3,500 for reforestation and 500 for windbreak purposes, and a charge of $4 per thousand was made for trees in excess of these amounts on each order. This policy continued till 1931, when any quantity ordered was again supplied free of charge. Following the end of the war in 1945, the demand became so great that the nurseries were unable to fill it, and for a number of years only a portion of each large order was filled. In 1953 the Department of Lands and Forests was authorized to again make a charge for trees, and at the present time the rate is $10 per thousand for all species except Scotch pine, for which $14 per thousand is charged.

In 1906 a statute was passed which permitted a township council to exempt a part of the woodland of a farm from taxation; it provided that exemption be extended to any part of a farm used for forestry purposes or being "woodlands"; provided that such exemption shall not be greater than one acre in ten acres of such farm and not more than twenty acres held under a single ownership.

> "'Woodlands' for the purpose of this paragraph shall mean lands having not less than four hundred trees per acre of all sizes, or three hundred trees, measuring over two inches in diameter or two hundred, measuring over five inches in diameter (all such measurements to be taken at four and one-half feet from the ground) of one or more of the following kinds: White or Norway Pine, White or Norway Spruce, Hemlock, tamarack, oak, ash, elm, hickory, basswood, tulip (White wood); black cherry, walnut, butternut, chestnut, hard maple, soft maple, cedar, sycamore, beech, black locust, or catalpa, or any other variety which may be designated by Order-in-Council, and which said lands have been set apart by the owner with the

> object chiefly, but not necessarily solely, of fostering the growth of the trees thereon and which are not used for grazing livestock".
> - R.S.O. 1950, c.24, s.5 (18).

In 1927 the exemption of taxation on woodland was made compulsory if applied for, and is interpreted as meaning planted as well as natural trees.

In 1938 The Assessment Act was amended to prevent the assessment being raised on land after it had been reforested and now reads as follows:

> "Land which has been planted for forestation or reforestation purposes shall not be assessed at a greater value by reason only of such planting".
> - The Assessment Act, R.S.O. 1950, c.24, s.33(12).

Both these Acts were designed to facilitate the planting of trees on private land and should be taken advantage of by citizens anxious to improve woodland conditions on their own property and at the same time benefit the whole community of the river valley.

Within the Middle Maitland Watershed there are only 14 private plantations, with a total of 104 acres.

2. <u>County Forests</u>

The County of Hastings was the first in the Province to interest itself in reforestation and as long ago as 1911 appointed a reforestation committee, which was instrumental in having The Counties Reforestation Act passed, which has since been incorporated in The Trees Act. The Committee also recommended* that "The Corporation of the County of Hastings purchase from the municipality of the Townships of Elzevir and Grimsthorpe certain lands containing 2,800 acres,

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* Minutes of the meeting of the Council of the County of Hastings, December 8, 1911.

more or less, for $200" as the nucleus of a county forest. However, no further action was taken and the Act lay dormant till 1922, when the present policy of county forests was laid down. The work is done under the authority of The Trees Act (R.S.O. 1950, c.399), which provides for the purchasing of land and the entering into agreements by the county for the management of such lands. No limit as to the size of the area is stated, so that some counties have plots of a few acres while others have forests of several thousand acres. If, however, a county wishes to enter into an agreement with the Minister of Lands and Forests for the planting and management of such county-owned land, it is preferred that the county purchase not less than 1,000 acres. The agreements which are in force at the present time run for a period of 30 years, during which time the Ontario Government agrees to establish the forest and pay the cost of such items as fencing, buildings, equipment, labour, maintenance, trees, etc. - in short, everything connected with the management of the forest.

At the end of the 30-year period the county has the privilege of exercising one of three options: First, to take the forest over from the Government and pay back the cost of establishment and maintenance without interest; second, to relinquish all claim to the forest, whereupon the Government will pay to the county the cost of the land without interest; third, the forest may be carried on as a joint undertaking by the Province and the county, each sharing half of the cost and half the profits.

It will be seen from the above summary of the agreement that all a county stands to lose on such a project is the interest for 30 years on the purchase price of the land. Also, it should be pointed out that in drawing up such a liberal scheme, it was done purposely to encourage the reforestation of land not suited to agriculture. Again, it was not the

intention of the Government to have the counties stop at a minimum of 1,000 acres, as the overhead necessary on an area of this size could very easily be spread over an area of five or even ten times the size. As a matter of fact, this is what happened in some counties where the councils have initiated a progressive reforestation policy.

This Act also provides that municipal councils of townships shall have all the powers, privileges and authority conferred on councils of counties, except that instead of issuing debentures to an amount not exceeding $25,000 they shall have power to levy, by special rate, a sum not exceeding $1,000 in any year for the purpose of providing for the purchase of land for planting and protecting the timber thereon.

The agreements which have been drawn up between the river valley Conservation Authorities and the Ontario Government to establish and manage the Authority forests are substantially the same as those made with the counties, except that the Government has agreed to pay half the cost of the land and the agreement for planting and management is to run for approximately fifty years. The Authorities pay taxes on the land, and some townships prefer this to the county agreement, where no taxes are paid.

The only County Forest which has been established on the watershed is Compartments 11 and 12 of the Huron County Forest located on Lots 16 and 17, Concession V of Morris Township. The property comprises 200 acres and was purchased in 1950 for $3,000. In 1951 a road system was built. In 1952, 96,400 trees were planted, comprising 46,800 white pine, 13,800 white spruce, 14,700 Scotch pine, 12,600 red pine, 4,150 white ash, 1,200 jack pine, 2,000 red maple and 1,150 white elm.

3. Municipal Forests

Municipal forests are areas owned and managed by municipalities other than counties. However, no municipality in the watershed has availed itself of the services offered to it.

The assistance with regard to the establishment of municipal forests and the supplying of free trees is still the policy of the Department of Lands and Forests. Moreover, as provided by The Trees Act (R.S.O. 1950, c. 399), it is possible for any city, town or village having a population of not less than 10,000 or any township council to enter into an agreement with private landowners for the reforestation of their property. The agreement will prescribe the cutting conditions of all trees planted, and such conditions will be subject to the approval of the Minister of Lands and Forests.

Provision is also made for exempting such lands from taxation and for making arrangements with the Dominion and Provincial Ministers of Labour regarding conditions of labour and payment of wages in connection with planting and conservation of such areas. - The Trees Act.

4. Demonstration Plantations

In 1922 the Provincial Government began the policy of assisting municipalities in the establishment of small forest plantations for the purpose of demonstrating the use of trees on marginal and submarginal land. To meet the requirements for such a plot the Government required that the area be on a well-travelled road so that as many people as possible could see it, that the municipality either purchase land or use land which was in its possession, fence it, and agree to give the area reasonable protection after planting. In return the Government agreed to supply the trees and pay the cost of planting and of supervising the work when the planting was in progress. In 1932, when Government funds were

curtailed, the policy governing these demonstration plots was changed, and from that time to the present the Government has not paid the cost of planting, although the other conditions governing the establishing of these plots have remained the same.

There are no demonstration plantations on the Middle Maitland Watershed. The value of such plots, if well cared for, in showing landowners what can be accomplished in a very few years by planting trees is so great that every township should endeavour to establish at least one plot.

5. Demonstration Woodlots

Demonstration woodlots are privately owned areas of woodland on which the owners have agreed to follow prescribed methods of woodlot management, outlined by the Department of Lands and Forests, under the Zone Forester and to permit access to the area by interested persons. Such demonstration woodlots and the influence they exert for the proper management of similar areas contribute to the total conservation effort in any watershed. However, no demonstration woodlots exist in the watershed at the present time.

6. School Forests

Trees have been sent out to schools in the watershed and have been distributed to children for planting on the home farm, and many of these have been used to form shelterbelts and windbreaks, but no school forests have been established.

7. 4-H Forestry Clubs

These clubs are organized by the Ontario Department of Agriculture, assisted by the Department of Lands and Forests, and must be sponsored by an organization interested in the improvement of woodland and reforestation.

Members must be between 12 and 21 years of age, and each member undertakes a project, such as marking a half-acre plot of woodland for thinning or reforesting a quarter-acre of land. Projects are judged annually on Achievement Day and prizes awarded; for this purpose the Department of Agriculture furnishes $3 per member and the sponsoring organization $1.50. Winners may enter the Provincial Inter-Forestry Club Competition.

To date none of these clubs have been founded in the Middle Maitland Watershed.

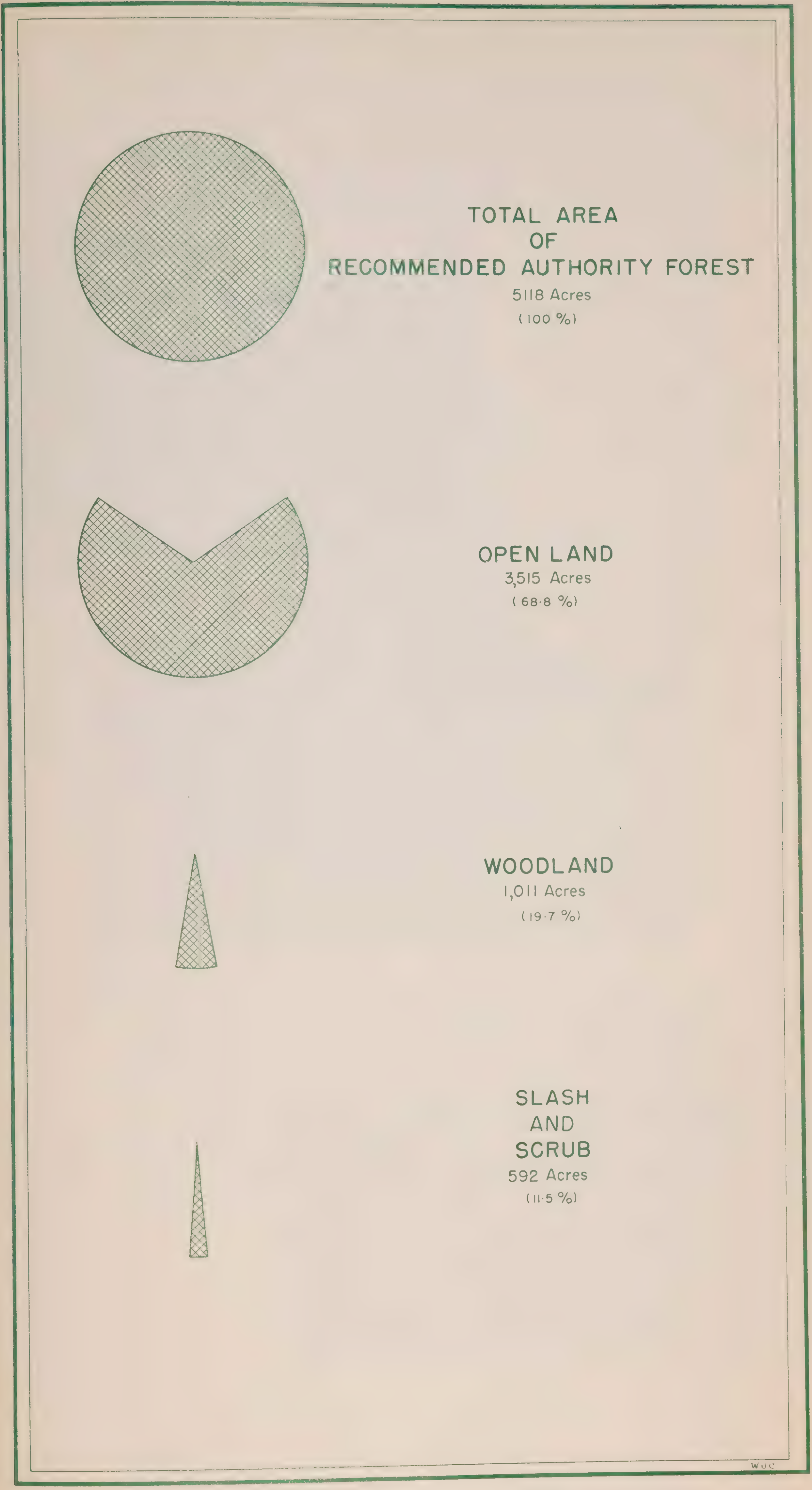
CHAPTER 5

FOREST CONSERVATION MEASURES REQUIRED

1. Middle Maitland Authority Forest

One of the most important conservation measures required on the Middle Maitland Watershed is the establishment of forest areas, to be called the Middle Maitland Forest, under the Conservation Authority. This forest will serve to protect the natural water-storage areas of the valley and will also utilize the submarginal farm lands which at present are scattered throughout the valley. This Forest has been defined in six areas, as shown in the accompanying table, with the acreages of woodland, scrub and cleared land in each area. The one-page map shows the location of these areas and the main tributary streams to which they supply water. The names given to these areas are taken from the township in which the properties are located. The large folding map, in the back of the report, gives more detail, showing the present tree cover, willow scrub, hawthorn and open land within the areas. The total acreage recommended for acquisition includes natural water-storage areas and reforestation land to the extent of 5,118 acres of which 1,011 acres have some form of tree cover, 426 acres are scrub, 166 acres are clear-cut woodlot or slash and 3,515 acres are open land.

In selecting the areas which it is felt should be set aside as permanent forest areas, adjacent swampland has been included irrespective of its present vegetative cover; that is, soft maple and white elm woods, willow and dogwood thickets, bog land and marsh areas have been included. In addition, adjacent woodland, particularly on slopes and covering springs, has been included. A minimum of land in better land classes has been recommended for reforestation; however, it was impossible to omit them entirely when they occupied positions immediately above springs or on a small part of a lot which was mostly composed of a poorer type of soil.



LAND CLASSIFICATION
RECOMMENDED AUTHORITY FOREST

Hilly land of this type should be reforested. Numerous areas similar to this occur in Morris Township.

In the Middle Maitland Watershed, 1.4 per cent. of the area (2,399 acres) is covered in scrub growth. These fields are rapidly becoming covered by willow scrub and this will cease to be productive land unless reforested or recleared, drained and placed under permanent pasture.

Poorly drained pasture may become covered in scrub willow and poplar. Such areas should be fenced from cattle and planted where possible. Thousands of acres of this type of land occur throughout the watershed.

(1) <u>Morris</u>

The reforestation land in Morris Township is located in seven tracts which are adjacent to Compartments 11 and 12 of the Huron County Forest. They cover 744 acres including 140 acres of woodland, 139 acres of scrubland and 465 acres of open land which are mostly pasture.

(2) <u>Grey Block</u>

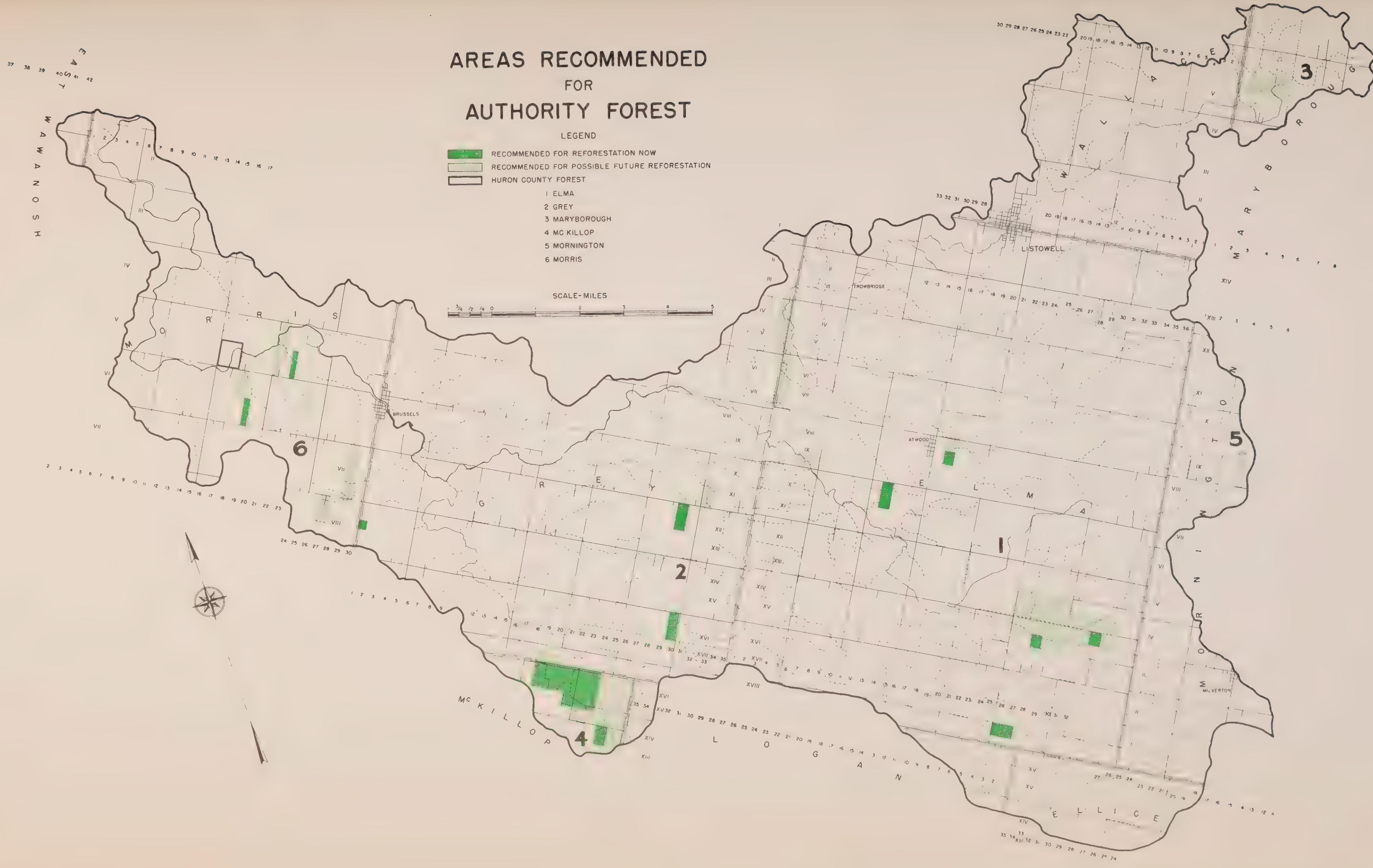
The Grey Township area contains 597 acres of land suitable for reforestation. Of this area, 488 acres are open land, 60 acres are woodland and 49 acres are scrubland. The area is contained in five tracts of land which are, at present, inferior pasture farms. As in the Elma area, if land values prove to be excessive, agreements between the owners and the Authority should be sought to maintain the present tree cover.

(3) <u>McKillop</u>

This is the second largest area of reforestation land on the watershed. The 1,538 acres are contained in 17 contiguous properties which form a single tract, most of which is inferior pasture land. The area contains 632 acres of woodland, mostly second-growth aspen, 16 acres of scrub and 860 acres of heavily drained pasture. This drainage forms the source area of Beauchamp Creek. The area should be reforested to protect the source area of this creek.

(4) <u>Elma Block</u>

The Township of Elma contains the largest area of land suitable for acquisition by the Authority for reforestation purposes. This area includes 2,010 acres of land of which 1,664 acres are open land, 179 acres are in tree cover and 167 acres are in scrub. This area is contained in six tracts of land; the largest area, which contains 1,472 acres, lies near the headwaters of the Boyle Drain. This land is nearly all poorly drained; most of it has been cleared and used as low-grade pasture. The other five tracts in the township are located in bog areas on the till plain or partly on


AREAS RECOMMENDED
FOR
AUTHORITY FOREST
LEGEND
RECOMMENDED FOR REFORESTATION NOW
RECOMMENDED FOR POSSIBLE FUTURE REFORESTATION
HURON COUNTY FOREST
1 ELMA
2 GREY
3 MARYBOROUGH
4 MC KILLOP
5 MORNINGTON
6 MORRIS
SCALE-MILES
LISTOWELL
TROWBRIDGE
ATWOOD
BRUSSELS
MILVERTON
EAST WAWANOSH
MORRIS
GREY
ELMA
WALLACE
MARYBOROUGH
MORNINGTON
ELLICE
LOGAN
McKILLOP

the slopes of gravel ridges. As the basic economy of a large part of the Middle Maitland Watershed is dairying and beef production, land is at a premium for pasture purposes. If this condition precludes the purchase of this land for reforestation due to the high cost of land, the Authority should endeavour to make agreements with the owners which will ensure the maintenance and improvement of the existing tree cover.

(5) Mornington

One of the tributaries of the Boyle Drain rises near the height of land in Mornington Township. This area contains 55 acres of cut-over hard maple - beech stand which should be acquired and reforested to protect the headwaters of the drain.

(6) Maryborough

The 174-acre tract recommended for acquisition in this township is important to the water economy of the area. This land contains the springs which are the source of the Middle Maitland River and thus the Authority should make an asserted effort to obtain the area. Until several years ago, these springs were protected by a mixed stand of mature sugar maple, beech and hemlock; however, this woodland has been clear-cut. Before the land is cleared for agriculture and the springs become completely exposed, the area should be acquired and reforested.

2. Scrubland

The total area of scrubland on the Middle Maitland Watershed is 2,399 acres of which 856 acres are dry scrub and 1,543 are wet scrub. In other words one acre in 70 is scrubland and absolutely non-productive. This is in one of the most highly productive agricultural areas of Southern Ontario.

Scrubland has been placed in two categories: dry-sited scrub which includes such species as hawthorn, apple

RECOMMENDED AUTHORITY FOREST (ACRES)

Area Name	No. of Tracts	Cleared	Wood-land	Scrub	Slash	Total
1. Elma Tp.	6	1,664	179	167		2,010
2. Grey Tp.	5	488	60	49		597
3. Maryborough Tp.	1	8			166	174
4. McKillop Tp.	1	890	632	16		1,538
5. Mornington Tp.	1			55		55
6. Morris Tp.	7	465	140	139		744
Total	21	3,515	1,011	426	166	5,118

and sumach and wet-sited scrub - willow, dogwood and alder. Dry-sited scrubland is usually land which has been overgrazed and neglected for many years. The soil may be unsuited to agriculture because of poor quality, excessive steepness or inaccessibility. On the other hand, it may be fairly good farmland which the owner has not been able or willing to maintain in good pasture so that shrubs which are unpalatable to cattle have taken over the area.

Wet-sited scrubland is land with imperfect drainage, often bordering swamps. The bush has been cleared from it but the subsequent pasture has been so poor that shrubs such as willow and dogwood, which require a damp site, have invaded the area.

Frequently scrub areas of these two types are suitable only for trees. They should be reforested and the acquisition of some of them by the Authority has been recommended. The wet-site areas present a problem in planting, and research should be undertaken to determine the best method of handling them. There appears to be a natural succession from neglected pasture land through willow scrub, trembling aspen, white elm and black ash to the climax types of silver maple - white elm or black ash - white elm - red maple, and every effort should be made to determine the best method of speeding up this succession.

In addition to the larger areas there are innumerable smaller areas, often in long strips along the borders of stream valleys, which will always be in private hands. The aggregate effect of this on stream flow is very considerable. These should be planted with trees to form part of the farm woodlots where they occur. Many of them should be placed under a reforestation and controlled woodlot scheme by agreement with the Authority, especially where they cover the sources of streams or steep slopes where erosion is or may become a problem. Under this scheme the owner would get considerable help

from the Authority in the establishment and maintenance of the woods, but would not be permitted to cut them indiscriminately. (See Controlled Woodlot Management).

3. <u>Private Reforestation and Woodlot Management</u>

The Middle Maitland Watershed contains a fairly large area of small tracts of land which are suitable for reforestation. As these tracts are too small and irregular to absorb into an Authority forest, they are more suitable for private planting. Reforestation, combined with the protection of natural woodlots, is essential if farmers are to have sufficient woodland to supply the local community with fuelwood, fence posts and poles, and to have a few sawlogs for sale which will provide a cash crop at times when the prices of other farm products are depressed. Reforestation of certain areas will not only mean that the land will be producing a crop where little or nothing of value is growing now, but it will also assist in providing adequate protection for the soil and will retard run-off of water from melting snow and rain, thus making for a more even stream flow throughout the year.

If the Authority is able to stimulate interest in private reforestation the resulting plantations will do much to assist the general woodland conservation program. The value of creating interest among the farmers on the watershed cannot be over-stressed. The Authority and municipal bodies can do a great deal towards establishing and managing the larger areas within the watershed; however, without the co-operative attitude of the private landowners in the watershed, the complete program of woodlot management and reforestation of the less productive lands cannot be accomplished.

The interest of private owners in reforestation may be fostered in many ways; the value of public education is of primary importance and is looked after by the Zone

A large number of small tracts of land within the Middle Maitland Watershed should be reforested by private individuals. This illustration shows a typical area of run-down pasture land adjoining the Maitland River which could be restored to usefulness through reforestation.

Forester in the district. The Authority could aid private reforestation programs by assisting the owners in the establishment of the private plantations.

To encourage private reforestation, other Authorities have purchased tree-planters to assist in the planting programs on the Authority Forests and for use in custom planting in privately owned plantations. The Saugeen Authority supplies a tree-planter, tractor and an experienced planting crew for the nominal sum of $2.50 per hour. Where the land is too rough or stony to utilize a tree-planter, the Authority will refund $10 per acre for each acre of land, which has been hand-planted, one year after planting.

A program of woodlot management should be one of the main forest conservation measures undertaken in the Middle Maitland Watershed. The woodlot inventory indicates 12,747 acres of woodland on the watershed, the vast majority of which is in need of some form of woodlot improvement. One of the most difficult problems confronting the private owner in the management of his woodland is the utilization of the small woodland products which can be readily made and handled by the owner. Some of these products such as fuelwood, pulpwood, bolts, posts and poles, if properly harvested, increase the productivity of the woodlot and the gross returns per acre. Very often it is the difficulty of marketing low-grade material which makes it almost impossible to carry out the necessary improvement work and any means which can be discovered of utilizing small and poor-grade wood should be developed to the fullest extent. At the present time interest is increasing in the possibility of manufacturing wood chips in the woodlot by means of a portable chipper. Such chips can be used for the manufacture of pulp for paper, and as bedding for cattle and litter for chickens which can subsequently be spread on fields to increase the humus content of the soil. They can be made from any species of wood, and tops and branches can be

Demonstration woodlots should be established throughout the watershed. These areas are developed in co-operation with interested woodlot owners and the Zone Forester. They serve to illustrate good forestry practices in woodlot management.

Large areas of second-growth aspen have been severely damaged by grazing. These areas should be fenced and the open spaces planted with more valuable species.

These piles of fuelwood have been derived from a selective logging operation. The logs have been cut from tops, branches and undesirable species. By adopting sound forestry practices, the financial returns from a woodlot can be greatly increased.

utilized. The number of pulp companies which can use hardwoods is limited at the present time and only those making kraft paper can use chips containing bark, but the demand for hardwood chips will increase and portable barkers are being developed. Every woodlot owner should consider the possibility of improving the quality of his woodlot by utilizing the low-grade material as chips.

4. Woodland Grazing

> "The most widespread abuse of forests is that of utilizing them as pasturage for animals. If this practice alone could be eliminated more than half the battle to save Ontario woodlots would be won. Forestry and pasturage cannot succeed on the same piece of ground, as diametrically opposite conditions are necessary for each."

> "It is foolish to consider replanting millions of acres to forests unless the owners of millions of acres already under forest are convinced of the necessity and economy of caring for them in such a manner that they will be perpetuated and improved."

The preceding quotations are from the Report of the Ontario Royal Commission on Forestry, 1947, in the section dealing with forestry on private lands. They do not present new themes, for as early as 1908 the problem was formally recognized in Ontario by legislation in the Exemption of Woodland from Taxation Act. This Act, which includes a "no grazing" clause, exempts from taxation one acre in ten used for forestry purposes. It is generally admitted that the Act, in offering to the woodland owner a very slight saving in taxes, has done little for woodland conservation. Additional recognition of the problem was accorded in the same year by inauguration of the policy of establishing Provincial Forest Stations centrally in extensive areas of submarginal lands. The first such station, St. Williams, in Norfolk County, was located to function as a forest nursery to supply seedlings to reforest submarginal lands. Since this program began several hundred million trees have been distributed by the Government, entailing an investment of millions of dollars. Meanwhile, after 40 years of a reforestation program designed

to retire submarginal lands to their most economic use, the destruction of existing woodlands on the same type of lands by domestic grazing has continued at an alarming rate.

In the Middle Maitland Watershed the survey of all the woodland showed that about 61.7 per cent was grazed. This percentage indicates that a larger percentage of the woodlands on the watershed is grazed than on many other watersheds in Southern Ontario. This fact should be given serious consideration by the Authority when planning the Conservation program for the area. In this report some thousands of acres are recommended for reforestation, both by the Authority and by private owners. It is indeed illogical to reforest one area while the woodland on the adjacent lot is being destroyed by grazing.

There are a number of reasons for the widespread practice of allowing woodland grazing. The woodlot has always been considered a pasture field even though the value of woodland pasture is low compared to cleared land. The reason for its low carrying capacity is partly because grass grown in the shade is not nearly as high in food value as that grown in full sunlight. The following statement in respect to woodland pasture has been made by leaders in agriculture: "On the whole, the opinion of the Agronomists is that, on the average, woodland pasture will produce about one-sixth the quantity of pasturage, and the quality will be about one-half as good as that of the improved pasture". Weeds are usually prolific in wooded pastures, often smothering most of the grass.

If shade is required for stock, it may be desirable to leave a portion of the woodlot in the pasture when fencing the woodlot. Another solution is to establish small groves of fast-growing hardwoods which can be temporarily fenced until the trees are sufficiently tall enough that browsing will not damage crown growth. Where springs of streams

that supply water for the stock are situated in the woodlot access may be made to a trough near the spring and the area should be fenced to prevent trampling.

The number of cattle permitted to graze and the size of the woodlot have a direct relationship to the damage which is done. A large woodlot, of course, is not as seriously damaged by a few head of cattle as a small one. However, in most cases where grazing is permitted over a number of seasons the damage is serious.

Livestock admitted to woodland browse on the leaves and shoots of small trees and ride them down, and by scuffing the surface roots of larger trees injure them and permit entry of fungous diseases.

Field observations indicate that cattle have preference habits in grazing woodlands. Unfortunately this preference is for the more economically desirable species such as maple, basswood, elm and beech, whereas undesirable species such as hornbeam, blue beech, dogwood and hawthorn are grazed only when cattle are seriously underfed. Coniferous species are rarely browsed. This combination of factors, under continued grazing, changes not only the quantity but the quality of the reproduction and so the succeeding stand. The poorer hardwood species, and conifers where these occur, are favoured. The invasion of pastures by cedar and hawthorn is an illustration of this grazing preference.

Continued overgrazing affects natural reproduction both directly and indirectly; directly in so far as it affects the reproduction itself and indirectly through its effect on the soil. Livestock trampling compacts the soil, breaks up the protective layer of litter, exposing the mineral soil to drying, and the cattle, by consuming the vegetation within reach, reduce the volume of litter naturally returned to the soil. It is this litter which keeps the soil open or porous and in a highly absorptive state. Thus water relations

are changed, which adversely affects the rate of tree growth and may early eliminate seedlings which manage to make a start in the compacted soil.

A woodland is doomed where conditions persist which will not permit natural regeneration. After a time with no new growth to replace larger trees which die of natural causes, the canopy begins to open up, and sunlight let in further dries out the soil. Weeds and later grasses which require plenty of light gain a foothold and a sod begins to form. In general tree seeds which germinate cannot compete with an established grass cover. As these effects of grazing progress the stand becomes open or park-like and eventually all the trees disappear.

Livestock grazing affects more than the growth of trees on the owner's land. Soil erosion in the woodland increases as the absorptive capacity and mechanical protection afforded the soil by the litter is reduced. The opened canopy exposes the soil to the erosive force of rain impact and a compacted soil forces overland movement of water. Livestock tend to follow trails in the woodland and these often become centres of serious erosion. Thus continued grazing increases surface run-off and soil erosion.

Soil losses and the amount of water which ran off the land were measured at the Soil Conservation Experiment Station, La Crosse, Wisconsin. The table* shows the results of six years of measurements on three separate watersheds having the same soil type.

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* Soil Conservation Service, U.S. Department of Agriculture, Forestry Handbook (Fourth Edition). 1948. Upper Mississippi Region. Compiled and edited by S.S. Locke, Chief, Regional Forestry Division.

This hard maple woodlot is heavily grazed and all regeneration as well as the natural covering of the forest floor has been destroyed.

Natural regeneration can be secured by fencing the area from cattle; the density of young growing stock can be increased by discing in the fall so that a more favourable seed bed exists when the trees seed.

	Run-Off Inches	Run-Off % of Total Precipitation	Soil Loss (Lbs. per Acre)
Watershed A (Grazed Woods)	2.31	1.17	2,126
Watershed B (Protected Woods)	.05	.02	19
Watershed C (Open Pasture)	.79	.40	866

Watershed A: 2.67 acres of second growth hardwoods. Slope 15 - 18 per cent. Grazed to optimum carrying capacity.
Watershed B: 11.5 acres of second growth hardwoods. Slope 25 - 50 per cent. Neither grazed nor burned.
Watershed C: 5.85 acres cleared of second growth timber in 1932. Slope 25 - 35 per cent. Grazed to optimum carrying capacity.

Basically the problem in grazing, in fact, in all woodlot forestry, is that a tree takes not one or two seasons but generally more than the lifespan of a man before it is ready for harvest. This makes the proof of woodland economics complicated and possibly beyond the understanding of many owners. It can be shown that in the long run the husbanding of the woodlot or submarginal land will return more dollars than the forage value which it may produce for livestock.

(a) The Economics of Woodland Grazing

Some examples of the economic fallacy of grazing woodlands are given.

(1) * The Wisconsin Agriculture Experiment Station measured the total yield per acre of dry matter from three types of pasture over a 5-year period in Richland County:

Improved pasture (grass and legume)	3,210 lbs.
Unimproved open pasture	1,453 lbs.
Woodland pasture	276 lbs.

Here the improvement of one acre of open pasture provided a gain of 1,757 pounds of feed, which is equivalent to the

* The Case Against Cows. Wisconsin Conservation Bulletin, December 1951.

forage from 6.4 acres of woodland producing at the rate of 276 pounds per acre. In this case the improvement of about 6½ acres of existing open pasture would provide all the additional roughage that could be obtained from 40 acres of woodland.

(2)* In Minnesota and Ohio a study of the grazing capacity of various types of pasture determined the protein and carbo-hydrate yield of the forage and the results are given in the following table. The figures are for a 6-month grazing season.

Number of Acres Required per Cow on Various Pastures

Kind of Pasture	Acres per Cow
Dense woods pasture	9 plus
Average woods pasture	4.5 to 9.0
Open woods pasture	3.0 to 4.5
Steep open pasture	2.3 to 3.6
Rolling land pasture	1.4 to 2.3
Bottom land pasture	1.1 to 1.4
Improved or legume pasture	.75 to 1.4

(Over Ontario the average allotted pasturage per animal unit for the grazing season is said to be 4 to 5 acres.)

(3)* The U.S. Soil Conservation Service co-operating with the Wisconsin Agriculture Experiment Station conducted studies which showed that the daily pasture cost per cow was greater in woodland pastures. Taxes and other charges against the land, fencing, costs of establishment and acres required per cow were all considered. The study showed the relative daily pasture costs per cow on different classes of pasture to be approximately as follows:

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* Soil Conservation Service, U.S. Department of Agriculture, Forestry Handbook (Fourth Edition). 1948. Upper Mississippi Region. Compiled and Edited by S.S. Locke, Chief, Regional Forestry Division.

Rotation pasture	5¢
Open permanent pasture	6¢
Improved pasture	5¢
Wooded pasture	17¢

At this rate, for a 180-day grazing season, woodland pasture cost $30.60 per cow, whereas on improved pasture the cost was $9.00. In other words, wooded pasture cost over three times as much as improved pasture.

(4)* In Ohio an ungrazed woodland adjacent and similar to a grazed woodland yielded a gross income from maple syrup production of $10.43 per acre per year greater than the grazed woods over a 5-year period (Damback, 1944).

(5) A fully timbered average maple stand, 60 years old, may yield about 4,000 board feet of saw timber per acre, net scale, in the Maitland area. Such a woodlot is virtually ruined by 20 years of heavy grazing, whereas 20 years of protection and no logging may increase the net volume to approximately 8,500 board feet per acre. The gain of 4,500 board feet is equivalent to an annual increase of 225 board feet per acre. At $28 per thousand on the stump this amounts to a mean annual gross income of $6.30 per acre over the period of utilizing only the increase in volume.

(b) <u>The Right of Public Concern in Woodland Grazing</u>

Continued woodland grazing is more than the private affair of the property owner. It becomes even more than a community interest because anything which contributes to soil loss and to increased surface run-off lowers the yield capacity of the land on the one hand and on the other aids to the flood hazard. Woodland grazing lessens the volume and value of forest products which reach the market and this influences all the economy dependent upon such supplies. In these respects woodland grazing becomes a prime concern

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* Westveld, R.H. and Peck, R.H. Forestry in Farm Management - Second Edition, revised. 1951.

of the Conservation Authority. It is far cheaper to maintain or restore natural existing woodlands than it is to create new forest areas artificially.

It is suggested that the policy of the Authority be education against woodland grazing by showing that it constitutes an actual loss in dollars and cents. Some of the preceding text points out that the farmer loses money by grazing his woodland and that he probably does not realize this. Of course it remains the choice of the farmer whether his plan for the farm will include a woodlot - but most farmers are open to sound suggestions on how to make a better living at farming. It should be recognized that the woodland is a forestry problem on the farm and that close liaison between woodland and agricultural specialists is required.

Thus it is necessary to show the farmer that the annual contribution of managed woodland to his economy can be significant and can far outweigh annual woodland forage value. At the same time it should be shown that it costs more per cow to carry stock on poor pasture than on good pasture and that the best way to obtain forage equivalent to that lost in fencing woodlands is to improve existing open pasture.

The Authority will find very little local or regional data on woodlands to prove their arguments on economic return, and the Authority should recommend that the appropriate authorities extend their studies in this field. However, the Authority may expect invaluable assistance to be willingly given in this field by local wood-using industries. Some of these have been located in the area for decades and are dependent on continued supply from local woodlands.

It has been suggested from different quarters that the fencing of woodlands is expensive and that part of such expense should be borne by the Authority. Such a program is under way in Halton County and may appeal to the other

counties in the watershed as well as the Grand Authority. However, it may be strongly argued that this is in effect subsidizing the production of livestock since it is the livestock which create the need for fences.

5. Diameter Limits

The basic method of control usually advocated is cutting to a diameter limit; that is, that all trees below a certain diameter - for example, fourteen inches - should not be cut. Such a regulation may or may not be good forestry. In most cases it would not be, because there would be much worthless material below this diameter limit, such as poplar, thorn, willow and other species, which should be taken out. At the same time there would be certain large trees above the diameter limit which should be left for the benefit of the forest as well as trees suitable for reseeding the area. The diameter limit should not be a fixed rule but simply a guiding principle, a sort of yardstick on which the landowner can base his calculations. In an area the size of the Middle Maitland Watershed a program of individual woodlot examination should not be too heavy a burden on the Conservation Authority.

Twenty counties, including Huron and Grey, have passed by-laws under The Trees Act (R.S.O. 1950, c.399) which empowers a county council to pass by-laws restricting and regulating the cutting of trees. In each case the by-law has fixed minimum diameter limits below which trees may not be cut except in special circumstances. The object of this is to prevent the cutting of trees at the time when they are putting on their greatest diameter growth. These limits are usually 5 or 6 inches for white cedar, red cedar and black locust and range from 10 inches to 16 inches in the various counties for all other species. The limits which have been set are actually far too low for the final crop trees as most trees are making their maximum diameter growth after they reach 18 inches in

COUNTY BY-LAWS RESTRICTING THE CUTTING OF TREES
UNDER THE TREES ACT

NTY	BY-LAW NO. & DATE	DBH or 18"st.	DIAMETER LIMITS IN INCHES 5	6	7	8	10	12	14	16
NT	849 2.11.48	18"	CE.	-	-	-	-	-	Rem.	-
CE	1452 13.6.53	18"	-	-	-	BIw.PO. CEw.	-	Rem.	ASw.BA. OA.ELr. MAb.MAh. PIw.PIr.	-
RIN	1011 & 1020 28.11.47 amended 23.1.48	18"	CEw.CEr	-	-	-	BA	Rem.	-	-
HAM & THUM-LAND	1695 8.4.53 1653	DBH	BI.ASb. LOb.CE. MA(soft) LAt.WI.	-	-	-	Rem.	-	-	-
IN	1499 24.1.47	DBH	CE.LOb.	-	-	-	-	Rem.	-	-
Y	1555 27.6.47	18"	-	CEw	-	PO.BIw.	-	Rem.	-	-
DI-ND	1331 13.5.49	18"	-	CEw.CEr	-	CHb.CHp POc.POl POb	BI.	BA.CT CO.CU GU.HE SY.TU HE.	Rem.	-
TON	819 15.4.47	18"	-	-	CE.	-	-	-	Rem.	-
ON	44 21.11.46	DBH	CE.	-	-	-	-	Rem.	-	-
BTON	921 12.6.48	18"	-	-	CE.	-	-	Rem.	-	-
DS/ EN-LLE	1727 13.6.53	-	-		-	-	-	-	-	-
COLN	1534 18.11.52	18"	-	CEw.CEr POt.POl POc.	-	-	-	-	-	Rem.
DLE-X	2226 12.3.47	18"	-	CEw.CEr	-	-	-	-	Rem.	-
FOLK	856 23.1.47	18"	-	CEw.CEr	-	-	-	-	Rem.	-
ORD	1412 27.1.48	DBH	CE.	-	-	-	-	Rem.	-	-
TH	854 25.1.47	DBH	CE.	-	-	-	-	-	-	Rem.
ER-O	1170 23.10.46	DBH	CE.	-	-	-	-	-	Rem.	-
LLING-ON	1733 15.6.46	DBH	CE	-	-	-	-	Rem.	-	-
IT-RTH	1468 12.5.49	18"	-	CE.	-	-	-	-	Rem.	-
K	2406 18.11.49	18"	See	special	note †		-	-	All species	-

NOTES: ¥ Exempt from By-law - Hawthorn, Choke Cherry, Red or Pin Cherry, Poplar, Ironwood, Manitoba Maple.

† Exempt from By-law - Hawthorn, Choke Cherry, Red or Pin Cherry, Poplar, Ironwood, Manitoba Maple, Wild Apple, Black Locust, Cedar, Tamarack, White Birch, Willow.

For abbreviations see separate sheet.

7.8.53.

COUNTY BY-LAWS RESTRICTING THE CUTTING OF TREES
UNDER THE TREES ACT

ABBREVIATIONS

DBH	=	Diameter breast high or 4½ feet above ground level.
18"st.	=	18" above ground level.
Rem.	=	Remainder.

SYMBOLS FOR TREE SPECIES

Coniferous Trees:

Cedar	-	CE
Cedar	White	CEw
Cedar	Red	CEr
Hemlock	-	HE
Pine	-	PI
Pine	Red	PIr
Pine	White	PIw
Larch	Tamarack	LAt

Deciduous Trees:

Ash	Black	ASb
Ash	White	ASw
Basswood	-	BA
Birch	-	BI
Birch	White	BIw
Cherry	Black	CHb
Cherry	Pin	CHp
Chestnut	-	CT
Coffee Tree	Kentucky	CO
Cucumber	-	CU
Elm	Rock	ELr
Gum	Black	GU
Hackberry	-	HC
Locust	Black	LOb
Maple	-	MA
Maple	Black	MAb
Maple	Hard	MAh
Oak	-	OA
Poplar	-	PO
Poplar	Balsam	POb
Poplar	Cottonwood	POc
Poplar	Large-tooth	POl
Poplar	Trembling	POt
Sycamore	-	SY
Tulip	-	TU
Willow	-	WI

diameter, but it is an elementary step in the right direction. Every county should have restrictions of this type and it is recommended that similar powers be extended to Conservation Authorities as a means of protecting existing woodland on their watersheds.

6. Forest Fire Protection in Southern Ontario

The task of protecting woodlands from fire in Southern Ontario presents a very different problem, or rather series of problems, from those of Northern Ontario, and consequently must be handled in a somewhat different manner. Fire is a serious question on the Middle Maitland Watershed and it is a question to which attention should be given at once.

Northern Ontario is predominantly forest land, the population is sparse, parties travelling through the forested areas are fairly readily accounted for by means of a permit system during the fire season, and watch is maintained for fire by means of look-out towers and air patrol.

In Southern Ontario, south of the Canadian Shield the land is normally potential agricultural land with the woodland surviving in isolated patches as farm woodlots or in larger more or less continuous blocks of swamp or sand up to ten thousand acres in extent. The population is, relatively speaking, fairly dense, no part of any woodland is more than two miles from the nearest human habitation and most roads are travelled by a comparatively large number of people.

In spite of the publicity given to the damage caused by fire the average person does not realize how serious this is. Though he may know that young growth and small trees are burned by surface fires he does not realize the extent of the less obvious damage such as the destruction of humus which itself preserves the condition and water-retaining capacity of the soil. When the humus and ground cover are destroyed the sun and dry winds remove the moisture required for tree growth and plant nutrients are destroyed. The heat of the fire also

injures the growing tissue inside the bark of older trees which are not actually burned, exposing the wood to attack by insects and fungi. Even though through time the wounds may be completely healed, the damage shows up as defects when the tree is cut for lumber.

Many landowners in Southern Ontario are so completely unaware of, or indifferent to, the damaging effects of fire that they deliberately set fire in peat land to burn off the peat, starting fires which it is next to impossible to extinguish. Such fires burn for months, even under the snow, destroying many acres of woodland every year, not only on the land of the person setting the fire but frequently spreading over land adjacent to it.

The first step in fire control is fire prevention, and the best assurance of prevention is an enlightened public opinion which will make every member of the rural community conscious of the seriousness of the fire damage and of his duty as a citizen to do all he can to prevent it. The farmer can prevent most fires in farm woodlots if he exercises the same care that he does around his home and buildings.

Experience in the United States has shown that the most effective fire protective systems in rural districts are those set up under a state organization with local wardens appointed by the state forester on the recommendation of the local town* councils. In the rural parts of the state of Maine each town appoints its own fire wardens who handle fire protection in the town quite independently of other towns. This means there is a lack of co-operation between towns, wardens receive little practical training, organization is loose, and as wardens hold office at the pleasure of the town council there is a serious lack of continuity in administration.

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* The "town" in the Eastern United States corresponds closely to the township in Canada.

In New Hampshire and Vermont wardens are appointed by the state forester on the recommendation of the council and in Vermont they serve until they resign or are removed for cause by the state forester.

Mr. H. H. Chapman, writing in the Journal of Forestry, states*: "It is not unreasonable to conclude that the ratio of 34 to 1 in damage per acre of woodland between these two states (Maine and New Hampshire) is the direct consequence of Maine's failure to depart from the 'fire bucket' principle of town organization."

From the evidence collected in the northern states of the United States, where conditions most nearly approximate those of rural Southern Ontario, it is apparent that the most effective fire protective systems are those set up under the following conditions:

(a) Where the system is organized under the direction and control of the state forester and the wardens in each town are appointed by him on the recommendation of the local council.

(b) Where wardens paid an annual retainer are actual residents in the locality. Usually they are farmers who have had practical instruction in fighting fire. They have the power to call out other local residents to help in fire-fighting and maintain a store of fire-fighting tools on their premises.

(c) Where the warden is assisted in his work by all members of the community. That is, his address and telephone number are known to everyone and fires are reported to him immediately.

(d) Where designated members of the community know that they are likely to be called on to fight fire and are paid so much per hour for the time they are so employed.

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* Journal of Forestry, Vol. 47, No. 2, 1949.

(e) Where every resident is thoroughly fire-conscious and realizes that loss of timber by fire is a loss to the whole community, and considers it his duty to prevent, report and fight fire.

(f) Where fires for burning brush and rubbish may be set only after a permit has been obtained from the local firewarden.

It is therefore recommended that the Authority set up a committee to determine the best method of providing fire protection for public and private lands, through the co-operation of the Department of Lands and Forests, for the protection of woodlands in the Middle Maitland Watershed.

CHAPTER 6

FOREST INSECTS AND DISEASES

1. Forest Insects

In any project, such as that proposed for the Middle Maitland Watershed, careful consideration should be given to the prevention of insect outbreaks and adequate arrangements made for the immediate application of control measures when these become necessary. While it is not possible to predict accurately the course insects may take under the ever-changing conditions of a newly forested area, there are a number of fundamental principles which, if applied, will greatly lessen their destructiveness.

It is important to avoid the planting of large areas of one kind of tree, otherwise conditions will be ideal for an outbreak of abnormal numbers of some insects which prefer the food afforded by that particular host. It is preferable to plant in blocks, the blocks distributed so that trees of one species are separated by blocks of different tree species. This tends to keep outbreaks localized until natural agencies bring them under control and facilitates direct control measures if such become necessary.

It is important to plant only the species of trees suitable to the site and existing growing conditions. Healthy, vigorous trees are certainly more resistant to insect attack than weak, struggling ones.

Over-mature and dead trees should be removed from the existing stands as these harbour bark-beetles and wood-boring insects which may become excessively abundant and attack healthy adjacent trees.

Care should be exercised to prevent ground fires. Even light ground fires are frequently followed by severe outbreaks of bark-beetles and wood-boring insects.

Woodcutting operations, sawmill sites and wood storage yards should be carefully supervised or they may become reservoirs of infestation.

It is essential that surveys for insect conditions be made each year so that any abnormal increase in insect populations may be noted and control operations initiated before they develop to outbreak proportions. Serious and widespread outbreaks are frequently prevented by prompt and well-timed spraying operations over a comparatively small area. It is therefore necessary that spraying equipment be available and that laneways be maintained within the plantations for spraying purposes. Outbreaks of an extensive nature can generally be brought under effective control by strip spraying. In this method, alternate strips of trees in large plantations are sprayed, thus reducing the initial infestation and at the same time causing the native parasites to concentrate and build up in the unsprayed portions. This reduces spraying operations and the number of lanes required for the passage of spraying equipment.

Owing to the danger of injury by the white pine weevil, white pine should not be planted in pure stands unless the stands are very densely stocked in a good site. It is better to grow white pine in mixture with some immune species such as the better hardwoods. The protecting species should be taller than the white pine, at least in the early years.

In conclusion, it should be recognized that protection against leaf-feeding insects is very desirable since defoliation of a tree weakens it and thus makes it more susceptible to attack by bark-beetles and wood-boring insects as well as by organisms which do not usually attack healthy trees but which will hasten the death of weakened trees. Leaf-feeding insects alone may kill a thrifty, broad-leaved deciduous tree by completely defoliating it for three years in succession. Conifers, however, are usually killed as a result of one complete defoliation.

2. Tree Diseases

Productive woodlands require protection against fire trespass, grazing animals and rodents, insects and disease. Protection is a part of forest management, and under a policy of sustained yield will be maintained in continuity. Good forest management is reflected in the health of woods and, conversely, damage on account of disease is often a sign of mismanagement or neglect. In general, an objective of maximum yield, with attendant intensive silviculture, is compatible with, and often facilitates, protection and disease control.

For the purpose of discussing their pathology and protection, the hardwoods may be considered separately from pine in natural stands or plantations. The chief diseases of the hardwoods are the various trunk, butt and root rots, and chronic stem cankers, which are all endemic and may cause serious damage under aggravating conditions. Woodlots on the Middle Maitland Watershed present very diverse conditions with respect to the incidence of these diseases, a circumstance which is usually related to their past history. Thus many containing old timber are in need of heavy preliminary salvage and sanitation cuttings as a result of mismanagement or neglect. Such cuttings should precede or be combined with cleanings and improvement cuttings, designed to improve the composition and structure of the stands. Having established a sanitary condition, normal care should maintain it and obviate loss on account of decay.

The wood rots are commonly thought of as diseases of mature and over-mature timber, but experience has shown that infection may occur at a very early age. In hardwood sprouts the stem may be infected from the parent stump. In older trees infection is chiefly through wounds, either of the root or trunk, which may be caused by fire, trampling by animals, insects, meteorological agencies, or by carelessness or accident in felling and other wood operations.

Hardwoods are commonly cut selectively and not infrequently in clear fellings. Few foresters will approve the latter system, which is in fact often intended as a liquidation of the property. A system based on yearly selection, or frequent periodic return to conveniently planned subdivisions, has obvious advantages for small woods, and is well adapted to the control of decay.

For many reasons "cleanings" in the reproduction are desirable, especially where the woods have been heavily cut. While favouring the valuable species, those sprouts which, on account of decay hazard, are of undesirable origin should be eliminated. Such will comprise sprouts from the larger stumps and those from above-ground position.

In harvest cuttings, which should recur at frequent intervals, the permissible volume allotted should include trees in which incipient decay is discovered and so far as possible those which have become a poor risk through injury or other circumstances.

White pine is found in young plantations and in natural stands, almost pure or mixed with hardwoods. From the latter stands it tends to disappear on account of hardwood competition, except on sites which are particularly favourable for its reproduction. The white pine blister rust, which with the well known shoot weevil is a principal enemy of the species, is a factor contributing towards the elimination of seedlings and young trees.

White pine should be encouraged on those sites which are naturally suited to its reproduction so that fairly compact growth may be secured, thereby facilitating the protection problem. It is an important and valuable species in Southern Ontario, and its cultivation should be promoted by the institution of effective blister rust control facilities.

White pine has become increasingly more important since European Pine Shoot Moth populations have increased to epidemic proportions. At the present time white pine appears to be the one species of pine, common to Southern Ontario, which is not seriously affected by this pest. Consequently it may be advisable, where site is not a controlling factor, to select white pine stock in preference to other pine species.

CHAPTER 7

LAND ACQUISITION

The problem of land acquisition in any part of agricultural Ontario, where practically all the land is privately owned, is one which requires careful approach. The ownership and use of land, especially for agricultural purposes, is considered by most citizens as one of their few remaining inalienable rights. However, where the good of the whole community is under consideration, such personal rights should be, and have been, overruled under the principle of eminent domain. Examples of such cases are the building of highways, the construction of power lines, and the acquiring of land for military purposes in the event of a national emergency.

In Southern Ontario compulsion has not been exercised to any great extent by the Government in planning proper land use schemes. But who would gainsay the fact that the acquiring of poor land on the Middle Maitland Watershed for conservation purposes constitutes a national emergency, and therefore requires a more permanent authority than the individual to bring it back to its proper use.

However, in dealing with land acquisition it should not be the desire of any authority to approach the problem in a dictatorial manner. It will require careful handling, and as a preliminary step in such work the people of the area should be acquainted with the purpose of the scheme, its ultimate benefits to the community, and by explanation and demonstration be gradually brought to the point where they will be glad to co-operate.

The only part of the Middle Maitland where large-scale transfers of property from private ownership to a forest authority would have to be made is in those areas which are recommended for acquisition because they are natural water-storage areas and reforestation land.

1. Methods of Acquiring Land

There are several ways in which land can be acquired and controlled for conservation purposes, and it is proposed to enumerate and discuss these briefly in this section.

(a) Transfer by Private Sale

The most satisfactory method of acquiring land is by private sale between the Conservation Authority concerned and the landowner. This method has been followed by the counties of Ontario in purchasing land for reforestation work in building up the system of county forests, which totals in round figures 90,000 acres. This method has its drawbacks, however, as individuals who have not the community's welfare at heart, or for one reason or another have an exaggerated idea of the value of their property, may block the completion of a unified area by refusing to sell. This was overcome in the State of New York, which has purchased over 450,000 acres of land for reforestation, by refusing to buy individual parcels of land unless there was a sufficient number in a group to make a contiguous block of 500 acres.

(b) Maximum Price per Acre

Another method which has been used has been to fix a maximum price per acre for this class of land, beyond which the forest authority is prohibited to go, allowance being made for the presence of good fencing and buildings on the properties, which in some cases have been removed by the vendors and allowed as part payment for the land.

(c) Agreements

Where owners of property prefer to retain their woodlots, or where parts of farms fall within the forest area prescribed, and providing the retaining of ownership does not jeopardize the complete conservation scheme, agreements could be made for the control and management of such areas.

This method has been adopted by the Dominion Forest Service in Nova Scotia, where it has been desirable to control wooded areas for experimental and conservation schemes, and in this particular case the agreements cover a period of twenty years.

In Ontario there is one example, at least, where a municipality leased a part of a farm for reforestation work for fifty years, and one United Counties' council has adopted the plan of taking easements on land for the same purpose.

(d) Control by Existing Legislation

Under the authority of the Private Forest Reserves Act (R.S.O. 1950, Chapter 288), the Minister of Lands and Forests, on recommendation to the Lieutenant-Governor in Council, may, with the consent of the owner of any land covered with forest or suitable for reforestation, declare such an area to be a private forest reserve. When such an arrangement is made the Minister or his representative may reforest such areas, supervise the improving and cutting, and prohibit the removal of trees by the owner without his consent, and also prohibit the grazing of the area by cattle.

(e) Life Lease

Many of the farms on the proposed forest, as already mentioned, are of low agricultural worth and are supporting families at the present time. The problem in such cases is not so much the purchase of the property as what will become of the family after the farm is acquired. In almost every case it would be impossible for the vendor to purchase another farm with the money he receives, except one which is of approximately the same value outside the forest. In some cases such farms are occupied by older people whose families have grown up and left the community. The removal of these from their properties might work undue hardship on them, and in fact in some cases they might become a burden on the

municipality. With some of these the plan of giving the vendor a life lease would be sufficient. In most cases such old people make little attempt at farming the whole property, but require only sufficient pasture for a cow or two, enough land for a garden, the house and buildings, and a supply of fuelwood. The plan of giving a life lease has been adopted in the case of two properties,* at least, on the county forests in Ontario, and has proved satisfactory to both contracting parties.

(f) Tax Delinquent Land

Under the Statutes of the Province of Ontario,† land which becomes tax delinquent is sold by the County Treasurer. In the case of a farm this is not done in practice until the land has been in default for three, or in some cases four, years. Even then the owner has the privilege of redeeming his property within a year. Where such lands are marginal or submarginal, they are sometimes bought for only a part of the area which is of special value, such as woodland, old buildings, or a good field or two. In some instances the poor land remains idle and frequently appears again at the tax sale. The fact that such land becomes tax delinquent is an indication in many cases that its ultimate use is forestry. Under the present Statutes the municipalities are not permitted, at the first sale at least, to acquire or reserve such land for conservation purposes. Consequently this report recommends that the Authority expropriate all tax delinquent land subject to the regulations of the Municipal Act.

(g) Expropriation

As a last resort in land purchases, or where the owners of abandoned land cannot be located, such areas can be acquired by expropriation. The Conservation Authorities Act, R.S.O. 1950, Chapter 62, Section 15 states:

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* Northumberland Forest and Angus Forest.

† The Assessment Act, R.S.O. 1950, c. 24, s. 143.

> "For the purpose of carrying out a scheme an authority shall have the power to purchase or acquire, and without the consent of the owner enter upon, take and expropriate any land which it may require and sell or otherwise deal with such land or other property".

Also under The Forestry Act (R.S.O. 1950, Chapter 147, Section 13) provision is made for the removal of settlers from lands unsuitable for farming. To quote:

> "Whenever in the opinion of the Minister, it is found that settlement has taken place on lands not suitable for agricultural purposes, and which said lands are required for forestry purposes, the Minister shall have the power to make arrangements for the removal of such settlers upon such terms as may be agreed upon".

As a matter of general interest, it should be stated that this Act also provides for the power to close the roads on lands taken over for forestry purposes, the setting apart of lands for settlement, and the removing of settlers from lands unsuitable for farming. It should also include, however, provision for acquiring permanent or community pastures, and pondage areas where these are required, as an integral part of a large conservation project.

2. <u>Cost of Land in the Proposed Authority Forest</u>

It would be impossible to give an accurate figure for the total purchase price of all land in the proposed forest without consulting the owners of the individual parcels. However, as an indication for arriving at the approximate cost the amounts paid by the several Conservation Authorities of the Province in purchasing land for their forests will serve as a guide.

TABLE SHOWING COSTS OF LAND PURCHASED FOR AUTHORITY FORESTS

Name of Authority Forest	Acres	Cost $	Cost per Acre $
Ausable	1,209	26,030.00	21.50
Ganaraska	6,360	78,766.45	12.40
Grand	1,245	17,118.16	13.75
Humber	709	22,000.00	31.00
Moira	1,314	7,805.00	5.95
Saugeen	2,026	9,196.00	4.55
Thames	2,525	14,059.14	5.70
Total	15,388	174,974.75	11.35

It should be pointed out that prices paid within the individual watersheds have varied greatly. The first three thousand acres purchased by the Ganaraska Authority averaged $6.78 per acre. Land purchases now average $12.40 per acre over the 6,360 acres which are now owned by the Authority. This average price increase was due to the policy of purchasing the poorer, denuded land first. This land has now been taken up and the more recent purchases have contained more woodland and potential woodland which has naturally raised the price. The very low cost of land in the Thames Watershed is explained by the fact that it is mostly burned-over swamp land with a peat soil which is of no economic value at the present time. Actually the average price of $5.70 per acre includes a ditch tax which exists as a lien against part of the property, so that the price of the land itself was closer to $1.00 per acre.

On the Thames Watershed, too, most of the poorest land has now been acquired and the cost of the remainder will certainly be higher. The maximum average price has

been paid by the Humber Authority. These high land values are due to suburban development and land speculation which has influenced the value of land for a considerable distance beyond the metropolitan area. The development of a comprehensive conservation program is a long-term project and it may be fifty years before the Authority has all the land required. The present policy of acquiring and reforesting some land each year is a sound one, and where the cost of certain areas is too high the Authority can afford to wait, because in many instances the land is deteriorating in productiveness through cutting, fire, grazing and neglect and eventually the price must fall too.

CHAPTER 8

SNOW FENCES

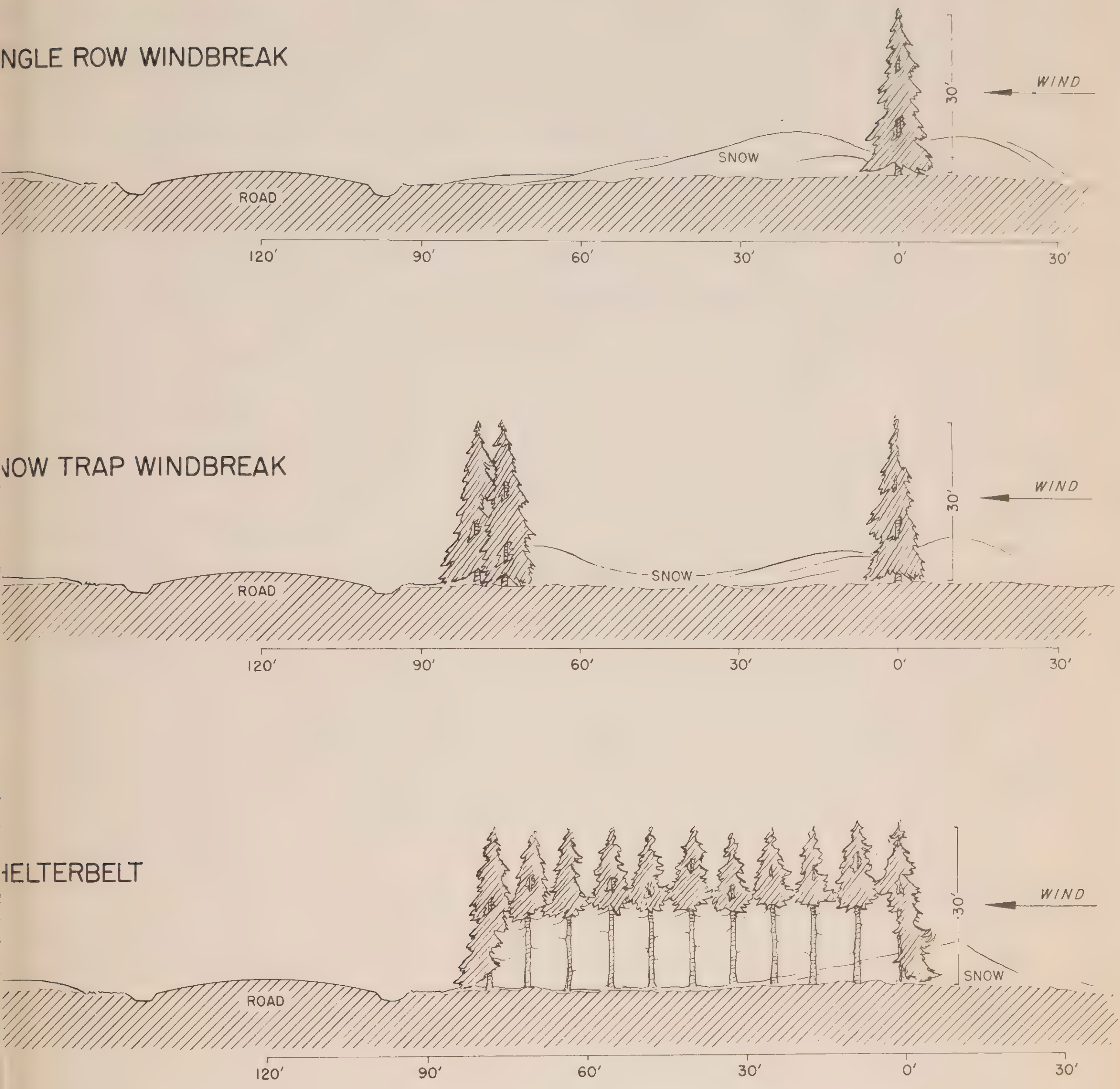
In the climate of Southern Ontario snow drifting may cause much inconvenience and sometimes hardship. Control can be readily effected by means of windbreaks and is dependent on proper placing with reference to lanes of travel and topographic features.

Where space is limited or land valuable lath or board fences are frequently used, but the cost of erection, removal or maintenance of these can be materially reduced by using trees as permanent windbreaks or shelterbelts. One or two rows of trees are usually referred to as a windbreak and more than two rows as a shelterbelt. The latter is preferable if space permits as it gives better and more permanent protection.

The prevailing winds in Southern Ontario are generally from the west so protection is usually required on the west side of north-south roads, on the north-west side of northeast-southwest roads, on the south-west side of northwest-southeast roads and on the north side of east-west roads.

The object of a snow fence is to mechanically reduce wind velocity near the ground in such a manner as to cause a drift to form where it will be least harmful. The reduction in velocity creates two pools of relatively calm air, a small one on the windward side and a much larger one on the leeward side, and it is here that drifts form, leaving the area further to the leeward free of drifts and comparatively free of snow. The deepest part of the calm pool is close to the windbreak; if the windbreak is open at the bottom - that is, composed of trees with few or no branches near the ground - the deepest part will move further to leeward. As winds become stronger both the depth expressed in terms of velocity reduction and the width of the pool on the leeward side will increase and the centre will tend to

SNOW FENCES



CROSS SECTIONS OF ROAD AND SNOW FENCES

Two methods of preventing drifts at the ends — left end of shelterbelt terminates at a hollow, right end is tapered down to the ground.

move further away from the windbreak.

A single row of trees, unless it is a dense coniferous type, is seldom dense enough to completely stop winter wind and may create drifts, just as poor placement of windbreaks may accentuate drifting conditions.

A wide belt of trees which will accumulate a large drift of snow on its windward side may be planted right to the edge of the road, the windward edge extending back a distance equal to three or four times the height of the trees and generally at least 100 feet.

In some places the snow trap type of windbreak is effectively used. It is composed of one or more rows of trees close to the road with a wide opening to windward and then a single row of trees. The single row arrests the first force of the wind and the snow is deposited in the opening. This has the advantage of requiring fewer trees than the shelterbelt and leaving the ground between open for cultivation in summer.

Any prejudice which may exist against windbreaks for protection against drifting snow on roads arises from poor or poorly placed windbreaks. If a windbreak has openings in it or if it ends abruptly streamer drifts will form. Windbreaks should be kept dense and tapered down at the ends by using progressively smaller species of trees and shrubs to prevent the formation of streamer drifts.

Trees are being used successfully as snow fences in Ontario by the Department of Highways, by railways and by a number of counties.

The practice of the Department is to acquire the land by purchase to a width of 100 feet from the centre line of the pavement and plant a three-row windbreak 80 feet from the centre line. The land is ploughed and cultivated and bushy stock about 2 feet high is used. Weeds are kept mowed between the rows and on the open strip between the

windbreak and the pavement, which entails a lot of work on the part of the maintenance crews in summer. The windbreaks are kept down to a height of 7 feet, partly because many farmers object to their view of the highway being obstructed and also because they are proud of their herds and fields which they want to be visible to passers-by. Also cutting the tops off the trees reduces the temptation, which some persons find irresistible, to cut them for Christmas trees.

County practice varies; sometimes the land is purchased, sometimes it is leased and sometimes it is planted by agreement. In all cases the County erects a fence behind the trees. In return for the use of the land one county plants a three-row windbreak around the farm buildings. Waterloo County has planted an excellent shelterbelt over four miles long on the west side of the county road running north through Linwood. Here the County has acquired a twelve-rod strip (198 feet) and planted the six-rod strip farther from the road, leaving the six-rod strip next to the road to catch the drift while the trees are small. When the trees get bigger it is planned to complete the shelterbelt by planting the six-rod strip next to the road. The trees used are transplant stock about one foot high obtained from the Department of Lands and Forests and planted in furrows. Weeds are kept mowed until the trees are large enough to shade them out.

The species of trees used are Scotch, jack, red and white pine, white and Norway spruce and white and red cedar. The Department of Highways uses both white and red cedar, which it obtains from areas where they are growing naturally, as well as some species usually considered as ornamental stock which it grows in its nurseries. These include mugho pine, barberry and Chinese elm. This last is the only hardwood tree used in windbreaks. It grows rapidly and its fine branching system makes it nearly as effective as an evergreen tree. The other common hardwoods such as Carolina poplar, white elm, silver maple and white ash are used fairly extensively in shelterbelts.

Snow fences are usually beneficial to crops in that they hold moisture in the fields in the form of snow in winter and reduce wind velocities and moisture loss by evaporation in summer. Occasionally they do cause ice to form over crops such as fall wheat and may be harmful in this way. The beneficial effects, however, outweigh the harmful ones so considerably that every encouragement should be given to their establishment in place of the removable type of lath fence currently in use.

CHAPTER 9

WINDBREAKS

In the process of clearing land for agriculture woodlots and belts of trees along fence lines have been removed which had served as natural shelterbelts. The restoration of these in the form of windbreaks is essential to a complete conservation program in many parts of Southern Ontario.

When proper species are used and windbreaks are correctly placed the effects are almost entirely beneficial. The effects may be direct or indirect, but in either case are the result of reduction in wind velocity. The effects of windbreaks on crops and cultivated fields may be listed as follows.

(a) Direct Effects

(1) Wind damage and lodging in small grains and corn is reduced or eliminated.

(2) Snow and the resultant moisture are more evenly distributed over fields, particularly on the higher spots where they are required most.

(3) Wind erosion of the soil is minimized.

(b) Indirect Effects

(1) Moisture loss by evaporation is reduced.

(2) Temperatures in the fields are raised, which may prevent frost damage, accelerate growth and even lengthen the growing season slightly.

(3) Erosion of the soil by water may be reduced by its more even distribution when released from snow.

The benefits of windbreaks to buildings in reducing heat loss in winter have been shown to be considerable. Experiments conducted in the United States proved that more than twice as much heat is lost from a house, per day or per hour, with a wind of 20 m.p.h. as with one of 5 m.p.h., and a windbreak can easily reduce wind velocities in this proportion. Used in this way they can often be made to form

Windbreaks and shelterbelts are established for numerous reasons. Here, a Norway and white spruce windbreak has been planted on both sides of the railway line to retard snow drifting. This method of snow control is found to be much less expensive than continually erecting and maintaining lath type snow fences.

In contrast with the farmstead on the right, which is virtually unprotected by windbreaks, the neighbouring farm buildings have all been enclosed by tree cover. The added protection, beauty and permanence which these trees give are clearly illustrated in this typical scene.

Most well planned farms will include windbreaks and shelterbelts to control wind erosion and snow drifting, or to add protection and comfort to the farm buildings.

an effective background for the house and a protection for farm buildings. Another advantage of windbreaks is that they provide shelter and runways for insectivorous birds and small animals.

Belts of trees comprising one or two rows are usually called windbreaks, and with more than two rows, shelterbelts. In Southern Ontario windbreaks as a rule give sufficient protection except where wind erosion of soil on rolling land is severe, when shelterbelts may be required. On level land windbreaks may nearly always be established along existing fence lines, but on rolling land consideration should be given to the contour of the land. The prevailing winds in Southern Ontario are generally from the west, so that the greatest protection will be derived from windbreaks on the west side, but the placement of windbreaks on the other three sides as well should be considered.

Both the height of the trees and the wind velocity influence the effective range of a windbreak. An average windbreak will reduce the ground velocity of a 20-mile wind 10 per cent or more for a distance of about 30 times the height of the trees. About one-fourth of this effect will be felt on the windward side of the windbreak and three-fourths on the leeward side. For example, if the trees are 40 feet high the total effective range with a 20-mile wind will be 30 x 40 or 1,200 feet, 300 feet of which will be on the windward side and 900 feet on the leeward side. Generally speaking, the reduction in velocity is greatest close to the windbreak and tapers out to zero further away. With higher wind velocities and/or higher trees the proportionate reduction and the effective range will be greater.

European alder is gaining great popularity as a windbreak tree because it is a nitrogen-fixer like the legumes and does not rob the soil to the same extent as non-

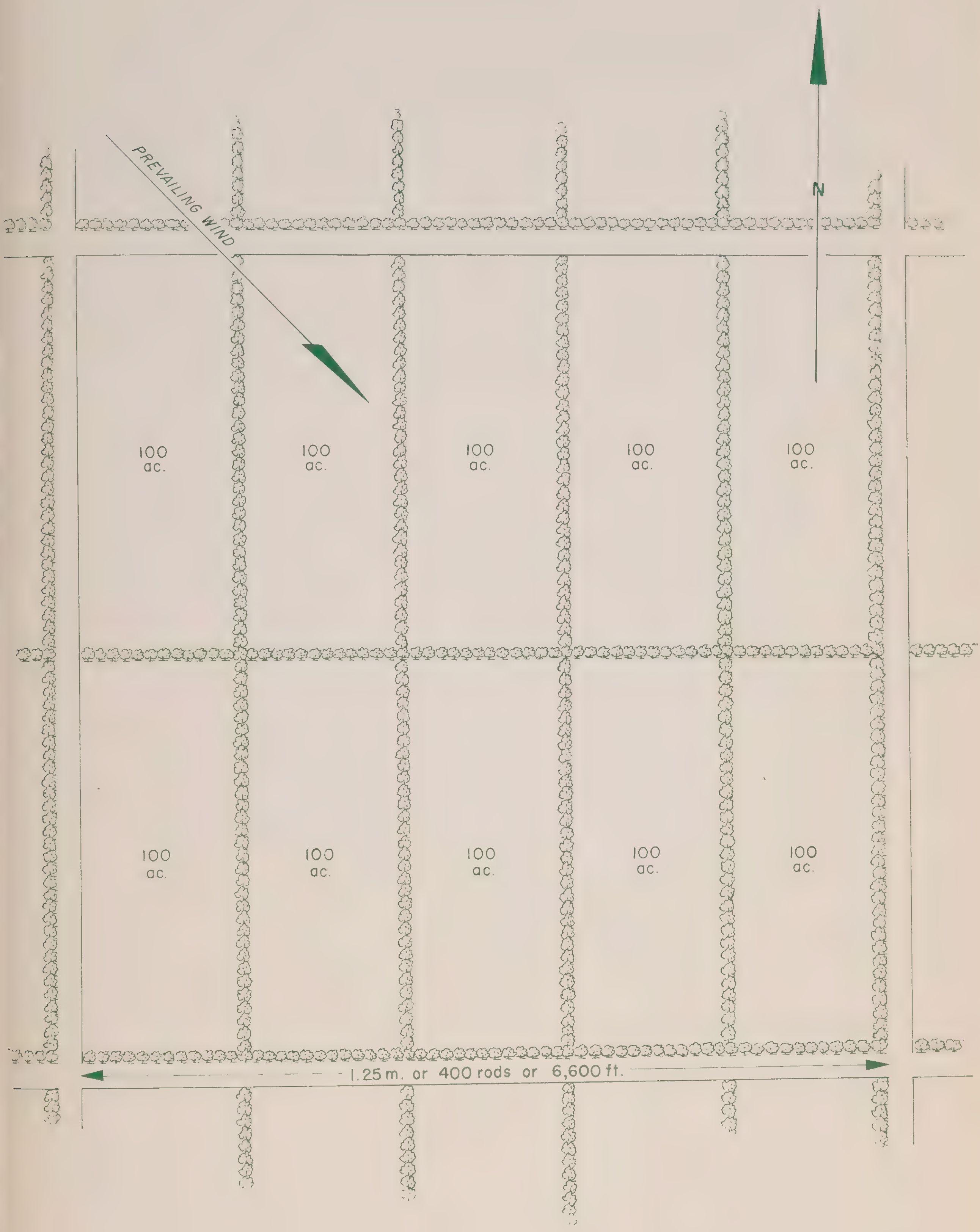
nitrogen-fixing species. In fact, tobacco is frequently planted close to it with little loss in size or vigour of the plants. As the robbing of the soil is one of the severest criticisms levelled against windbreaks, consideration should also be given to the planting of such leguminous trees as honey locust and caragana on certain sites.

One consideration that should be kept in mind is that under certain circumstances windbreaks may cause air stagnation, which may increase temperature and moisture conditions to a dangerous degree in summer or increase frost damage in spring and fall on small areas, particularly in hollows. Where this is likely to occur, windbreaks should be planted so as to guide the flow of air past such spots. Where these conditions develop after the windbreaks are established they may be relieved by judicious opening up of the windbreaks.

Experience has shown that windbreaks are an asset to any farm, that their adverse effects, if any, are local and easily remedied, and that in many areas they are essential to the control of soil erosion by wind. It is therefore recommended that the Authority encourage the establishment of windbreaks by private owners in every way.

It is recommended that the Authority institute a windbreak-planting program, especially in the areas which have been more recently cleared for tobacco where tracts of 20 or 30 acres and more have been stripped of all cover. This program could include the furnishing of a tree-planting machine at a nominal rental to owners for the purpose of establishing windbreaks which would break up tobacco farms into 10-acre fields.

WINDBREAK PLAN
for
1,000 ACRE BLOCK



This plan shows the minimum windbreak requirements for a 1,000 acre block on level land. Woodlots and plantations will replace some of this and placement will have to be adjusted according to topography and soil on rolling land.

WATER

CHAPTER 1

GENERAL HYDRAULIC PROBLEMS

Hydraulics as applied to conservation deals with the measurement and control of run-off from river drainage basins. Measurement has to do with such factors as precipitation - both rain and snow - the topography and vegetative covering of the area and the daily gauging of the flow of the river at selected points. Control deals with the prevention of floods by the use of reservoirs and other structures, and the increase of summer flow.

Floods which are caused by the natural run-off from river basins have occurred from time to time in Southern Ontario ever since records were first kept. Evidence of these can be found in diaries going back well over 150 years and from newspaper records for at least 100 years. Most of this run-off occurs in the spring, with the result that there is too much water in our rivers at the time of the year when it is needed least and very little, if any, during midsummer when it is required most. In addition to the flooding which is caused by spring run-off, occasional floods occur during the summer on watersheds which have little natural protection. These summer floods do serious damage to crops. Such floods are not confined to a few of our largest rivers, but records show that all rivers of any consequence have from time to time caused serious damage in this way.

When Ontario was mostly covered with forest and the natural reservoirs, such as large swamps, had not been interfered with, severe flooding probably was not as frequent as it is today because these two factors had an ameliorating effect on the flow of water. Land clearing and drainage were necessary to open up the country for agriculture, but in some respects these were carried beyond the point of necessity,

thereby aggravating the flood situation. In order now to regain a more or less stable condition of the rivers and streams, certain conservation measures such as the reclaiming of large swamps and water storage areas, the reforestation of marginal and submarginal land, and also proper land use practices as indicated by farm planning whereby the run-off from gently sloping land can be controlled by contour cultivation, terracing and strip-cropping, must be carried out. Such methods aim to control water where it falls on the land, and if this could always be done, it would be the ideal solution of the flood problem. But to minimize the required flood storage in a large watershed, a program of improved land use would need the co-operation of a great many individual farmers. This would take many years to accomplish. Therefore, more immediate measures are also necessary, especially where urban centres are frequently flooded.

One of the first problems facing the hydraulic engineer is to estimate or measure the run-off from a drainage basin which causes flooding farther down the valley. This includes a careful examination of rainfall over the years at different times of the year, which in turn presupposes that weather stations have been established in the area. Topography, types of soil, the amount of vegetative covering, particularly tree growth, on the area, and the gradient of the river, which has a bearing on the rapidity with which the water travels to the river's mouth, must all be carefully studied. If no gauging stations have been established then the run-off must be computed by taking the above factors into consideration and an approximate figure of flow determined by comparison with a neighbouring drainage basin which has gauge records, in order to decide how much protection by the use of reservoirs is required. If, on the other hand, gauges have been established, by which a daily

record is kept of the amount of water going down the channel at certain points, then a more accurate determination can be made of how much protection is needed. Fortunately there are some hydrometric records for the Maitland River dating from 1912, and although the periods of records are short and intermittent they are invaluable in determining the rate and amount of run-off from the area.

/ After the amount of run-off has been measured by whichever means are available to the engineer, it will give him a figure of flow which will indicate how much of this water will have to be taken care of by different methods in order to give the necessary protection where flooding is taking place. This means that a reconnaissance survey of the whole watershed must be made in order that suitable valleys may be selected where dams can be built for the storage of the required amount of water. When more than a sufficient number of such reservoir sites have been selected, each must be measured as to its capacity, and the required number chosen to hold back sufficient water to solve the flood problem. In addition, wherever a dam is to be built, some subsurface exploratory work must be done at the site to make certain that the dam will have a proper foundation. Only after this preliminary work has been carried out can the reservoirs be chosen, the actual designing of the dam structures undertaken, and the work carried through to completion.

While conservation reservoirs are usually built for the purpose of preventing floods, they are needed just as much in Southern Ontario for increasing summer flow. This has become increasingly important in recent years because rivers with extreme low flow and those which dry up entirely are a health menace to the communities through which they pass. Summer flow is necessary for flushing out the channel; to furnish water for industrial plants; for the practice of good

agriculture; and is absolutely necessary for dilution where urban municipalities empty the effluent of their sewage disposal plants or raw sewage into the river.

The building of dams for the prevention of flooding and the increasing of summer flow is a comparatively new concept in engineering. It is only since the turn of the century that structures of this kind have been used in North America for this purpose. The older methods included such projects as straightening and widening the river channel and removing obstructions such as islands in the river, narrow bridges and other man-made works which obstructed the flow or caused ice jams. Also for such work a river was occasionally diverted into another watershed, or dikes were built to hold it within its banks. Such practices are aimed at one thing only, namely to get rid of water as quickly as possible. They do not take into consideration the necessity of holding water at the headwaters for deep infiltration or retaining it for summer flow throughout the year. On some rivers in Ontario channel improvements, diversions and even dikes must be carried out and built, especially where dams and reservoirs are not economical and summer flow is not a major problem.

CHAPTER 2

DESCRIPTIONS

1. The Maitland Watershed (Fig. H-1)

The Maitland River empties into Lake Huron at the Town of Goderich. The watershed is roughly rectangular in shape and is contiguous on the north with the Saugeen Watershed, on the east with the Conestogo Watershed, and on the south with the Thames and Bayfield Watersheds. It measures about 37 miles east to west and 27 miles north to south. Five miles from Lake Huron the watershed abruptly narrows to a width of only 4½ miles and from there it funnels through Goderich (where it is only 1½ miles wide) to Lake Huron.

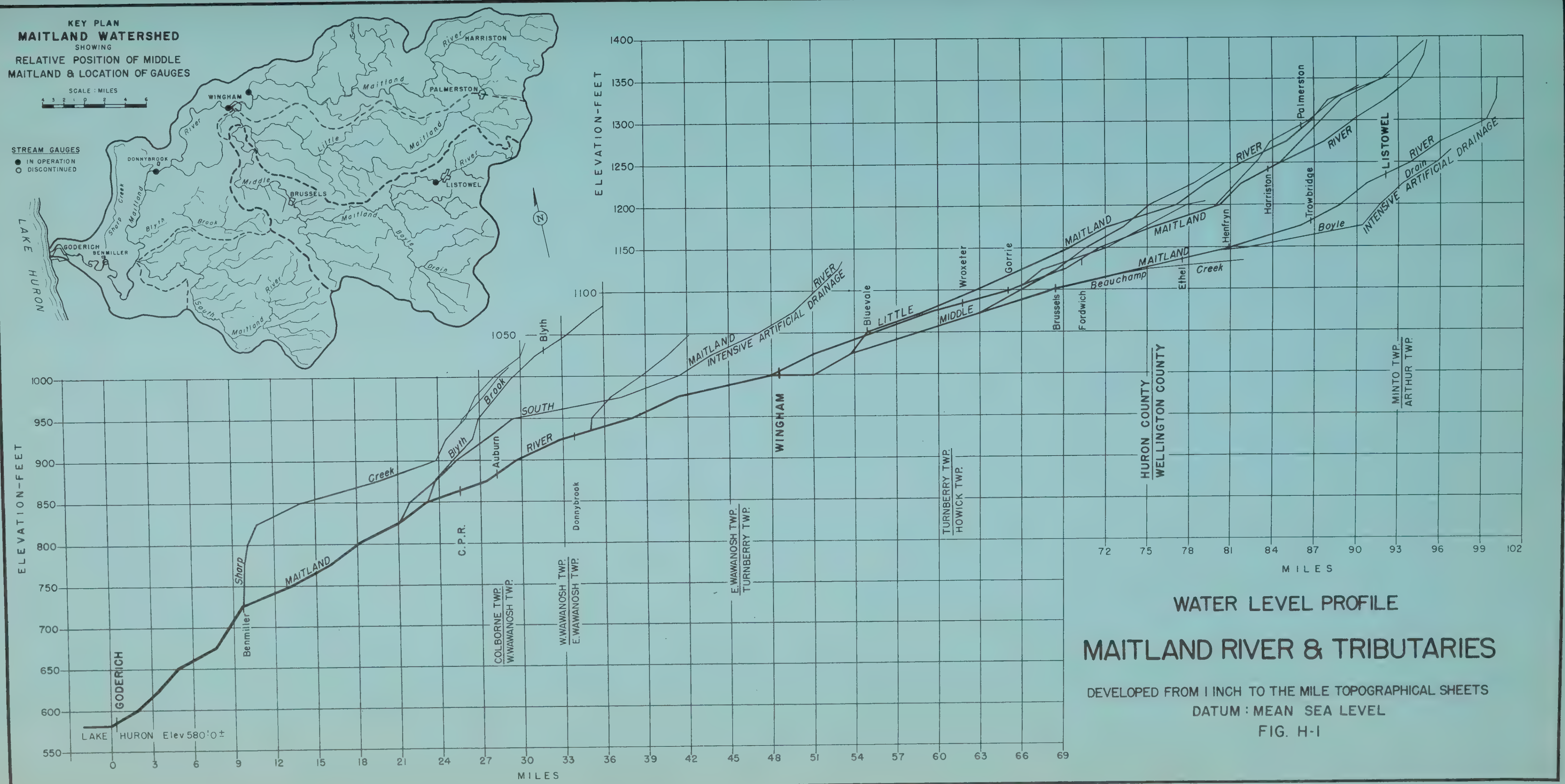
The Maitland Watershed is drained by four major tributaries, the respective drainage areas from north to south being:-

River	Drainage Area Square Miles
The Main Maitland	419.18
The Little Maitland	148.80
The Middle Maitland	257.97
The South Maitland	158.25
Total for the Watershed	984.20

2. The Middle Maitland Drainage Area (Fig. H-2)

The Middle Maitland Watershed is the concern of this report. It is roughly crescent-shaped and consists of the south-easterly segment of the Maitland Watershed and is about a quarter of its area. As the crow flies it is about 26 miles long east and west or 36 miles along the crescent. Its greatest width is 16 miles, tapering to less than 2 miles at the easterly and westerly ends, with an average width of about 7 miles.

It lies in the Counties of Huron and Perth and comprises parts of the Townships of Wallace, Elma and Grey and small portions of the Townships of Logan, Ellice, Turnberry,



WATER LEVEL PROFILE

MAITLAND RIVER & TRIBUTARIES

DEVELOPED FROM 1 INCH TO THE MILE TOPOGRAPHICAL SHEETS
DATUM : MEAN SEA LEVEL
FIG. H-1

Mornington, Marlborough and East Wawanosh. Located on it are the Towns of Brussels and Listowel and part of the incorporated village of Milverton. Non-incorporated villages are: Atwood, Monkton, Henfryn, Ethel, Trowbridge and Cranbrook.

The Middle Maitland River rises 8 miles above the Town of Listowel. From its source it flows westerly through Listowel, continues westerly for 6 miles, turns southerly for about 3 miles and then swings westerly for 3 miles where it is joined by the Boyle Drain tributary; thence westerly another 9 miles where it is joined by Beauchamp Creek; thence northerly 3 miles it passes through the Town of Brussels and continues another 15 miles in an irregular northerly course to its confluence with the Little Maitland River, an overall distance from the headwaters of about 47 miles.

The fall and gradients of the river from point to point are shown in the table below.

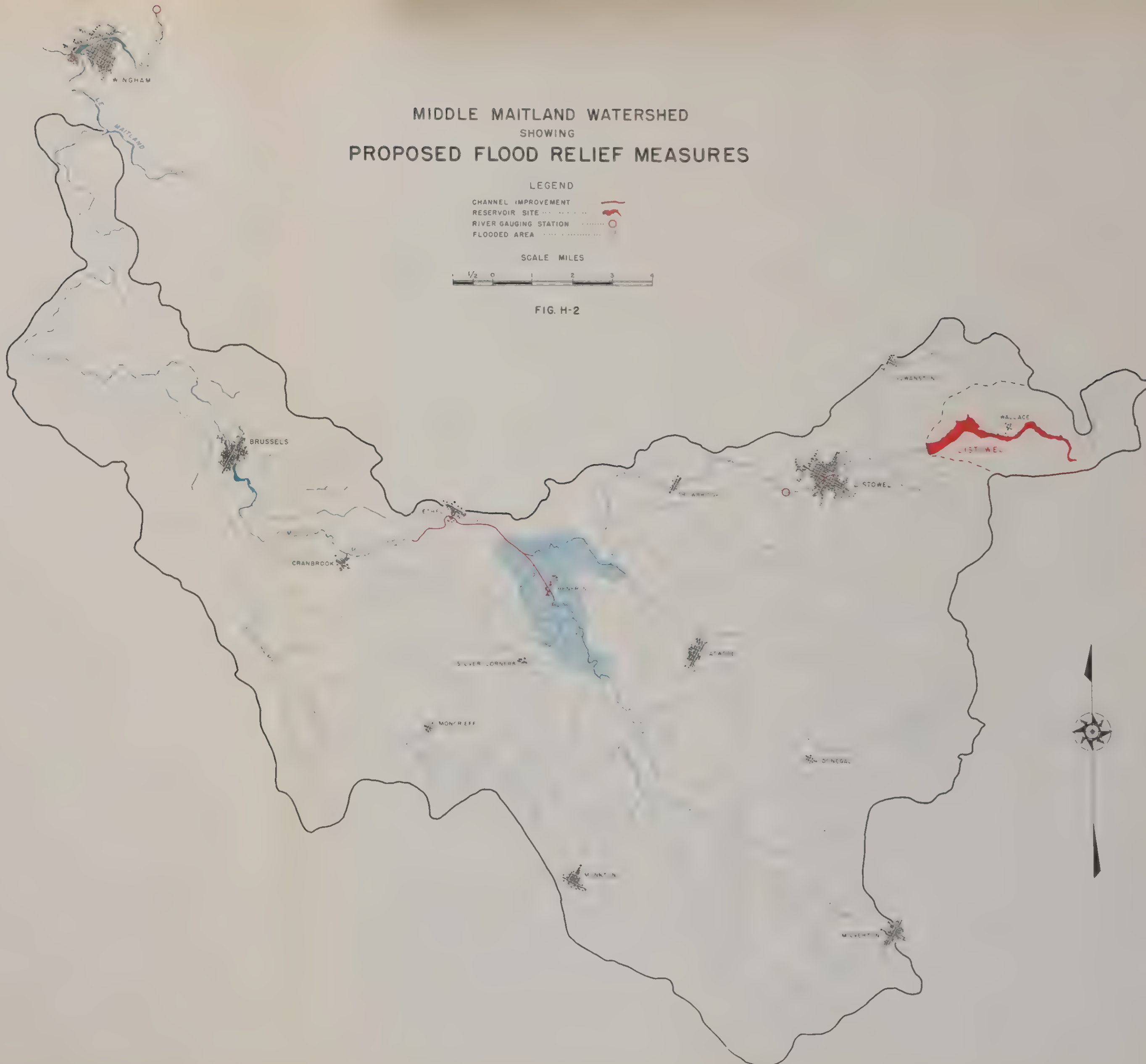
TABLE H-1

THE FALL AND GRADIENTS OF THE MIDDLE MAITLAND

Section		Distance in Miles	Fall in Feet	Gradient Feet per Mile
From	To			
Headwaters	Listowel	7.7	115	14.9
Listowel	Trowbridge	5.5	55	10.0
Trowbridge	Confluence with Boyle Drain	6.8	35	5.2
Confluence with Boyle Drain	Brussels	12.0	46	3.8
Brussels	Confluence with Little Maitland	14.8	75	5.1

3. <u>The Boyle Drain Drainage Area</u> (Fig. H-2)

Middle Maitland has two major tributaries, viz. Beauchamp Creek and the Boyle Drain, with drainage areas of 41.94 and 164.01 square miles respectively. These tributary drainage areas are adjacent to one another and form the southerly segment of the Middle Branch watershed, the Boyle Drain area being the south-east corner.



MIDDLE MAITLAND WATERSHED
SHOWING
PROPOSED FLOOD RELIEF MEASURES

FIG. H-2

CHAPTER 3

FLOODS (1834-1953)

The earliest accounts of the Maitland River made no mention of floods; occasional references to "extensive flats" suggested that such areas were subject to inundation during the usual freshets of each spring break-up. Mahlon Burwell, Deputy Surveyor, in a letter dated November 13, 1827, gave a description of the river, then called the Menesetunk:

> "The River Menesetunk is about half the size of the Thames. It is a fine River of pure clean water. Its banks afford numerous eligible situations for country seats to the right and left, sufficiently elevated and in variety to add beauty to their appearance and in general they are easy of access, and the flats extensive .... The rapidity of its current will compare with that of the River Thames, or Grand River, excepting that for several miles above the outlets of those rivers, their waters are apparently dead while the current of the Menesetunk continues to within half a mile of its entrance into Lake Huron".

Burwell's surveying operations in the neighbourhood of the Maitland occupied only a part of the summer months; he first encountered the river on the 24th of May, 1827, and left on July 5 to return to Guelph; if there was a freshet in the early spring, he was not there to witness it.

It was not until the year 1834 that the early settlers in the vicinity of Goderich placed on record their observations of a break-up of the river:

> "The next morning, February 22nd, of 1834, they watched the ice go out, the great cakes cracking and smashing in the wake of vanquished winter. The spring was early ..."

Between 1834 and 1868, the few scattered references to floods on the Maitland came from Turnberry Township, north of the present town of Wingham, and from the mouth of the river at Goderich.

The first recorded occurrence of a flood on the Middle Maitland was the report, in March, 1868, of the drowning of a farmer, "on the 12th Concession of Elma", who was

attempting to cross the river in a canoe, the river being "swollen to a great volume". "Even the gravel road (in Elma) was submerged to a considerable depth." The location of the submerged part of the road, and the scene of the drowning, were not more exactly defined, but it is possible that the present Boyle Drain was the swollen stream, some three miles south of Atwood, where it crosses Highway No. 23.

A severe flood at Brussels, April 13 and 14, 1873, caused "considerable damage, swamping bridges, mill-dams, &c". Mr. Vanstone, the mill-owner, also reported the loss of two thousand saw-logs, besides other damage to his property.

During the next ten years, there were no reports of floods on the Maitland. That of April 9 and 10, 1883, caused losses at Goderich amounting to over $15,000, while at Listowel, cellars were flooded and bridges damaged.

> "The rapid thaw on Tuesday (April 10) had the effect of causing the river to rise very rapidly, and to a greater height than usual. Quite a number of cellars were flooded, the foot-bridge on Inkerman-street carried away, and that on Bismarck-street considerably disturbed".

The Middle Maitland Watershed and the adjacent watershed of the Nith River appear to have been directly in the path of a disastrous thunderstorm that struck the area on the night of August 18, 1883, and that caused unprecedented damage. The following account is taken from the Toronto Globe of Tuesday the 21st.

> "Listowel, Aug. 19.- About ten o'clock last night a fearful rain-storm accompanied with terrible thunder and lightning broke over this place. About six this morning the citizens were alarmed by the ringing of the fire bell, and amid peals of thunder and terrific lightning hastened to the business part of the town to save all that was possible. In a short time the water flooded Main and Wallace streets, filling all the cellars, and in many of the business places the water was from a foot to twenty inches deep on the floors, doing an immense amount of damage to goods of all description. Several buildings were carried away and smashed to atoms. Bridges and sidewalks were also greatly damaged. Several very narrow escapes from drowning occurred. ... It is impossible at present to estimate the loss. Reports from the surrounding country say whole fields of grain in shocks have been swept away, and many uncut are totally ruined".

An account of this flood at Listowel, published many years later, summed up the estimated losses: "Damage to the extent of $25,000 was caused to bridges and sidewalks all of which had to be rebuilt; and damage to private property could hardly be estimated". (Listowel, Past and Present, 1921)

A similar story came from Wingham, where "the Maitland River has risen twelve feet since Saturday morning (18th), and if it continues rising today (20th) the main street will be flooded". A little later it was reported: "The Maitland River is still rising at the rate of six inches per hour, and the streets and cellars of lower Wingham are flooded".

Brussels appears to have suffered even more serious losses. According to the dispatch to the Toronto Globe:

> "On Saturday night (18th) the rain fell in torrents all night, accompanied by thunder and lightning, rain falling six inches on the level. On Sunday morning (19th) the river had risen to the highest water mark ever known, and kept rising until Monday noon (20th), when it had risen three feet higher than ever known before. It has destroyed all the crops growing on any flats, also bridges on the river, and all culverts, making the roads entirely impassable. The first damage done here was the taking away of Vanstone's temporary dam, and what work was done on their new dam. The flood-wood carried away the smoke-stack of Livingstone's flax-mill on Sunday night. The large skating rink of W. R. Wilson went to pieces and floated away, taking with it James Buyer's lumber sheds and contents, also his waggon shop and paint shop and contents, a two-storey building; also T. Watson's implement sheds. When the foregoing went away they came against the main bridge with a crash, and wrecked it so that it is impassable, though still hanging on the abutments. It also carried away Livingstone's flax store-house and tow, the greater part of which was rescued. In the township of Grey four bridges have gone, and fears are entertained for several more. In Morris several have also gone. The railroad has no trains running today. ... The railroad bridge at Ethel is expected to go unless the water subsides, as there is a very heavy jam of flood-wood against it. The Henfryn bridge is reported gone. McAllister's milldam in Grey and Leech's dam in Bluevale have been swept away, Mr. Leech losing about $4,000 worth of logs. Wm. Milne's boom broke early on Sunday, loosing about a quarter of a million feet of lumber. A young man was drowned at Ethel by the name of Henry Ferguson, who was assisting to save sawlogs for his employer".

The known losses at Brussels were estimated at $17,200, besides "any amount of smaller losses".

The spring freshet of April 15, 1886, would probably have caused little damage but for an accident in which two persons lost their lives. A party of young men and women from the vicinity of Sunshine undertook to "ride the flood" in two boats, homeward bound from a point near Brussels. One of the boats struck a submerged obstacle, throwing the occupants into the water, and two of them were drowned.

For the ensuing twelve years, no reports of floods on the Maitland have been found; but the flood of April 11 and 12, 1899, was considered "almost equal to that of August, 1883". While Wingham was hard hit, the worst damage seems to have been done at Listowel, where the progressive extension of the stores of Main and Wallace Streets over the river channel had confined the stream to the conduit through which it still flows. The danger of this restriction of the channel was pointed out in the Listowel Standard, April 14, 1899: "The erection of buildings over the river and the placing of obstructions in the river-bed, which are being added to year by year, are largely responsible for the annual flooding which Listowel is subject to, and which unless remedied, is liable to cause disaster worse than any that has yet overtaken the town".

According to the Standard, the flood of 1899 was caused by the sudden melting of an unusually large accumulation of snow and a heavy fall of rain on the 11th of April. That night the river overflowed its banks, turning Wallace, Bismarck, Inkerman and Elma Streets into "temporary canals" and flooding many buildings from two to twelve inches over the floors.

> "One of the posts supporting the new addition at the rear of Karges' shoe store on Main Street was carried away by a cake of ice striking it, and the building was in imminent danger of topling over into the river, but fortunately the remaining supports held it up."

By the morning of the 12th the water had considerably abated, and it was thought that the worst of the flood was over.

> "The hot sun on Wednesday (the 12th), however, caused a rapid thaw of the remaining snow, and the water from further up stream began to come down in great volume, the river rising again during the afternoon until by 7 p.m. it had reached a higher level than at any time. Wallace street was converted into a pond ... and other low-lying streets were also closed to everything except navigation..... By Thursday morning (13th) the river had fallen fully five feet, and the colder temperature gave the water a good chance to get away. Considering that several of the bridges and sidewalks were submerged, the town came off very lucky, the only damage reported being a section of the plank walk of Bismarck street carried away and washouts on some of the streets".

This estimate of the damage evidently referred only to town property; the damage to private property and to stored goods must have been more serious. Nevertheless, the flood of 1899 is not reckoned among the most severe from which Listowel has suffered. The "Big Three" are those of August 1883, April 1912, and March 1948.

On Easter Monday, April 8, 1912, the Toronto Globe carried the following dispatch, dated at Listowel on Easter Day, the 7th:

> "This town is experiencing one of the worst floods in its history. The spring freshets have been very heavy, and the rain of last night (6th) and this morning has raised the river many feet above its level. ... The majority of the buildings along the river are built right out to the water's edge, some of them having balconies built out over the water. If the river continues to rise the damage will be very severe."

Like the slightly less severe flood of 1899, this disaster came in two waves, the second higher than the first. "One of the worst floods in its history", this was the second of the "Big Three". The Listowel Banner, April 11, 1912, supplied the particulars.

The flood was attributed to "the repeatedly heavy falls of snow during the winter, and the way in which the cold weather held on through March". Good Friday (5th)

Main Street, Listowel, April 6, 1912. "The tide was turned westward, and rose higher and higher until the front entrance of the Arlington (Hotel) was barricaded by ten inches of water."

Wallace Street, Listowel, April 6, 1912. "At three o'clock the water was rising at the rate of an inch every five minutes. It had reached the windows at the old woollen mill. Now it had reached the Queen's (Hotel) and was well up Inkerman Street on both sides of the main thoroughfare."

was like a summer's day, and it was somewhat casually observed that the water was rising. In the evening the banks overflowed, and the lower part of Wallace Street was under water. "As the hours went by the water continued to rise until it reached the corner of Main, and then it gradually receded ." It was hoped that the worst was over.

But Saturday (6th) was as warm as the preceding day, and

> "with the turn of the afternoon the waters rose again and once more flooded the streets. This time not only Wallace but Main also was flooded, and the few visitors from the country saw sights they are not likely soon to forget. ... Soon, all too soon for the storekeepers, the whole of the business establishments on the north side of Main street were cut off from purchasers, and everyone who could be pressed into the service was at work lifting all the articles that could be damaged from the floors to some elevated positions. Soon the water extended not only the length of the business portion of the street but the width as well, until the storekeepers on the south side began to sit on the anxious seat and remove all goods likely to be injured by the incursion of the water. Between seven and eight the water ceased to rise, but the receding was slow, and on Sunday morning (7th) Main street was still impassable on the North side while Wallace street could only be negotiated with rubber boots".

The street on the south side of the Queen's Hotel was washed out to a depth of two feet. A similar washout occurred "in the passageway between Mr. Walter's and Mr. Stewart's store"; while "at the back of the Vandrick store a solid driveway ... was undermined and the tons of earth carried round a corner".

By Sunday noon, the waters had receded sufficiently to enable pedestrians to walk on either side of Wallace Street. The weather turned colder, and the flood was checked.

Meantime, washouts were reported from many points on roads and railways, and all traffic was at a standstill. Many of the delayed passengers were "enjoying" their Easter holidays, and these were, in most cases, robbed of their pleasure and prevented from returning to their work.

"They saw Listowel under the most depressing circumstances, and one summarized his experiences rather humorously under the statement that he could have had boating in the streets on Saturday, skating on Sunday and snow shoeing on Monday". The Coates bridge on the "Second of Elma" was so damaged that traffic was impossible.

The Wingham Advance, April 11, gave a full account of damage done in that town, and supplied some further details of conditions in the surrounding country. Six bridges on the Maitland north of Wingham were reported gone; a horse and buggy were seen going down in the flood; in Morris Township, the approach to the new iron bridge on the first concession was washed out, while the bridges known as Clark's, Sunshine, and Clegg's were carried away; the approach to Zetland bridge was badly washed out, "even down to the old corduroy of the early days". A washout occurred on the Grand Trunk Railway line at Atwood. "Altogether, the damage done by the spring flood in Ontario is perhaps the greatest on record; at least the greatest for many years".

A flash flood, on Sunday, July 1, 1917, came as "the climax to the very heavy downpours of the last few weeks", and the immediate result of a near cloudburst that occurred on the night of June 30. The dispatch to the Toronto Mail and Empire probably exaggerated when it referred to this as the "highest flood of many years", but the particulars given provided evidence of a severe flood, filling cellars, covering gardens to a depth of "several feet", sweeping away fences in the surrounding country, and causing serious damage to crops.

During the ensuing eleven years no serious floods were reported from the Middle Maitland. In 1929 there were two, one on March 14, the other on April 6. The first of

these was described in a dispatch to the Stratford Beacon-Herald, March 15, 1929:

> "Fed by the melting snow as well as a very heavy rainfall which commenced on Wednesday (13th) and lasted till noon on Thursday (14th), the river had reached threatening proportions at a late hour. Property owners and tenants downtown and in the business section have had to move their goods to safety from their cellars, in several cases the water being as high as the furnace doors. At the Queen's Hotel on Wallace Street, McIntyre's garage on Inkerman Street, and Sangster's Clover Mill on Bismarck Street, the rushing waters have completely submerged the streets. ... The flood is the worst that had been recorded here for some years."

Though the flood of April 6, 1929, was severely felt in the country round about Listowel and Wingham, "Listowel was very fortunate in escaping with very little damage". According to the Listowel Banner, April 11, 1929, "Sections of the district were flooded, bridges and dams washed away, and washouts occurred on the railroads in many places". Among the sufferers were the villages of Gorrie, Bluevale, Fordwich and Wroxeter, where dams and bridges were swept away, as a result of "torrential rains on Thursday (4th) and Friday (5th), which poured a big volume of water into the rivers". The reports indicated that the North Branch of the Maitland was much more seriously affected than was the Middle Maitland.

Once again there followed an interval of about ten years in which no serious floods occurred on the Middle Maitland. Then followed the flood of April 8, 1940, which caused only minor damage. In the Atwood Bee (incorporated into the pages of the Listowel Banner) of April 11, 1940, it was stated that in the early part of the week (Monday being the 8th), the Maitland river flooded the 8th, 10th, and 12th Concessions (of Elma Township), blocking the roads to traffic and endangering the Canadian National Railway tracks west of Atwood. "The high water also took away the iron bridge on the farm of Mr. Stanley Strachan and moved it about ten rods down the stream".

The next serious flood occurred on April 5 and 6, 1947. The news reports made reference to a rather wide area in which damage was done; but the only damage that was mentioned in the Middle Maitland Watershed occurred at Henfryn, where a portion of the main railway bed was washed out.

The flood of March 19, 1948, was the third, and some maintained, the worst, of the "Big Three". Damage at Wingham was estimated at "more than $1,000,000"; the losses at Goderich were by one report (Globe and Mail) stated to be "more than $6,000,000", and by another (Toronto Telegram), $60,000: it seems improbable that either of these figures was correct, but the readers of newspapers were without any sound basis for judging between them.

In Listowel no figures were given for the total amount of private losses, but one department store reckoned its loss at $7,000 or more, and "there was scarcely a downtown store that did not receive damage of some description to goods, premises, and in some cases both".

The Listowel Banner of March 25, 1948, gave a full account of the disaster.

> "Friday's flood (19th) was the third and by far the greatest in Listowel's history. Torrential rains and unseasonably warm weather turned the usually placid Maitland stream, which flows through the centre of the town, into an uncontrollable river that surged through homes and most business premises, bringing damage, yet inestimable but which has proved so far to reach many thousands of dollars."
>
> "Several ice floes, trapped at the river's entrance to the town, are believed to be at least partially responsible for the rapidity of the overflow. With its outlet reduced and backed with an ever increasing volume of water, the stream was not long in climbing over the channel to sprawl along Wallace and other surrounding streets. Within half an hour, water was trickling down Main Street and with water rising at the rate of more than half-an-inch a minute, merchants had little or no time to prepare for the flood. As a result, stores and merchandise became literally soaked, especially true of Wallace and Main Streets and business places immediately above or near the underground water passage. ... Save for the none too secure railway bridge at the south end of

Main Street, Listowel, March 19, 1948. "The flood is the worst in the history of this 96-year-old town. Within little more than one hour from the time water first reached over the banks to touch the main thoroughfare, two blocks of the business section were completely inundated."

Wallace Street, Listowel, March 19, 1948. "Several ice floes, trapped at the river's entrance to the town, are believed to be at least partially responsible for the rapidity of the overflow. With its outlet reduced, the stream was not long in climbing over the channel to sprawl along Wallace and other surrounding streets."

the town, Listowel was divided in two sections with the townfolk gathered at both sides helplessly watching the four-feet of water swirling about, wreaking havoc all through the down town area. ... It was fortunate that Listowel experienced no loss of life. ...

"Water continued to rise until near nine o'clock (Friday night) ... It was not until early dawn (20th) that satisfactory diminishing of flood water was apparent. Just after dawn merchants were able to make their way down through the business section. A confusion of filthy streets and seemingly hopeless debris greeted them everywhere. All through Saturday and far into the night, merchants labored to bring about some degree of order to the dishevelled merchandise, and work is still going on, with no way of determining the exact losses, possibly for weeks and in some cases even later.

"It was not until Sunday that cellars became dry enough to enter, and heating systems, which had been completely inundated, were put back into operation. ... Property damage cannot be ascertained, but heaving floors and bulging walls started to put in an appearance as fires began drying out the buildings."

One comparison with the flood of 1912 seems to be based on reliable measurements. Records of the 1912 rampage indicated that the water rose to a depth of ten inches at the Arlington Hotel, at the corner of Main and Dodd Streets. During the 1948 flood, the water stood three feet deep at the same corner. At its peak, the water level in Listowel, Friday evening, the 19th, had been 18 feet above normal, and, at its deepest point, some five feet over the street. A complete statement of the damage done was never compiled.

The memory of the big flood of '48 was still fresh in the minds of the merchants of Listowel when, on April 4, 1950, the "swollen Maitland River, fed by melting ice and snow and aggravated by steady rain, rose dangerously high, then subsided". Just so had the river behaved on at least two previous occasions: a dangerous rise, a slackening off, and then a new peak. Storekeepers were out at five o'clock in the morning, "keeping an anxious eye on the mounting river level", and piling their stocks on counters and high shelves, or hauling them away to places of safer storage. This time

their precautions were unnecessary, but the town did not escape wholly without damage. According to the Banner of the 6th:

> "About 3:30 p.m. Tuesday (4th) the water finally reached the front steps of the Royal Hotel, having covered Wallace Street to a depth of more than 12 inches in front of Stan Stonehouse's garage and completely surrounded L. & W. Jackson Motors building, swirling around on to Inkermam Street, then with the cessation of the rain, the waters gradually at first, and then faster, slipped back toward the river course, and by evening the danger point appeared past."

The damage done was confined to the retaining walls and underpinning of the buildings that line the banks and span the conduit by which the river passes under Wallace and Main Streets.

> "The heavy volume and force of the water apparently undermined the cement retaining wall on the east side of the river, and a large section gave way. A portion of the side wall and the rear wall of Mr. W. A. Johnstone's building collapsed, and had it not been for posts supporting the floor at the rear of the building greater damage would have resulted. The sturdy cement wall in the centre of the river bed supporting the building occupied by Mr. Johnstone was also undermined and badly damaged. About fourteen feet of the south end of the wall was broken and fell into the river bed, permitting the floor in the Jewellery store to sag. The full extent of the damage to the buildings will not be known until a thorough investigation has been made."

A minor flood was recorded on the Middle Maitland on April 25, 1951. According to a dispatch to the Toronto Globe, of the 26th, "the smaller streams on the Maitland were pouring over their banks in the Ethel district". No damage was mentioned.

On May 25, 1953, a "cyclonic wind" and a "downpour of rain" passed over the Middle Maitland Watershed, resulting in wind damage and considerable flooding. The Brussels Post, May 27, described the scene: "flattened barns; livestock trapped, killed and injured; ruined orchards; fields flooded with the heavy downpour and rising water of rivers and creeks". The Listowel Banner, May 28, reported: "In Listowel

the swollen Maitland River overflowed its banks in several places...... Cellars in many business places and homes were affected by water. Gardens in the lower end of the town, particularly around the section known as Little England, resembled miniature lakes". The damage by flood appears nowhere to have been serious; like the July flood of 1917, and that of August 1883, this storm is of special interest because of the evidence it affords of the ever-present possibility of a flash flood in the summer months.

A spell of mild weather from February 15 to March 2, 1954, produced a flood threat at Listowel and Wingham marked by four distinct peaks. Heavy rains on February 15 caused a "flood scare" in Listowel the following day; a jam formed at the underground conduit, but broke up in the course of the day. A second peak occurred at Wingham on February 21, and a third on the 23rd. These in turn gave way to cooler weather, and "residents of Lower Wingham heaved a sigh of relief". All this was followed on February 28 by further rains and a new peak on March 1 that threatened to repeat the great flood of 1948. The ice above Listowel broke up and jammed at the conduit. Persistent efforts with pike-poles and the use of 40 pounds of dynamite met with good success. The water rose to within a foot of the street level, but the jam was broken and the waters subsided.

In the course of the 120 years that have elapsed since 1834, there are well-authenticated records of 35 periods of high water on the Maitland River (all branches), of varying degrees of severity. Seventeen of these affected the Middle Maitland, and have been reviewed in this chapter. The accompanying table shows the frequency and relative severity of the known floods over the whole of the Maitland Watershed.

Wallace Street, Listowel, March 1, 1954. Breaking up large ice cakes to prevent jamming at the entrance to the underground conduit. Water rose to within a foot of the top of the opening, threatening a repetition of the 1948 flood.

Wallace Street, Listowel, March 1, 1954. Dynamite was used to blast the ice jam that formed at the entrance to the underground conduit through which this branch of the Maitland River passes under the business section of Listowel.

Listowel, March 1, 1954. The Maitland River flooded many homes near the southerly limits of the town, below the business section.

There is in these records no indication of a tendency toward either increased frequency of floods or increased severity. It seems probable that in the earlier decades of the period under review some floods passed without being recorded, perhaps without being observed, and that the improved news services of the more recent decades have left few if any of the floods unreported. It is also possible that some records exist that have not been discovered, which further search, and the co-operation of those in whose possession they remain, may bring to light. That the later floods have in some cases occasioned greater property damage than did the earlier ones is the result of the increasing extent of encroachment on the river bed and the increasing value of the property exposed to flooding, rather than to the increased severity of the floods or to the height to which the waters have risen. At Listowel, the effects of a flood have on several occasions been more directly related to the presence or absence of ice and the consequent blocking of the underground conduit than to the volume of water in the river.

The available records of flood damage on the Maitland River provide almost no basis for estimating the extent of the property damage done. The published reports either ignore entirely the question of the money value of the losses incurred, or present a few spectacular items in what is clearly a long tally, and leave the rest to the reader's imagination. In the face of the known range of variation of the severity of floods, it is not possible to use the few scattered items of factual record and non-factual estimate as a basis for calculating the total losses in a century of major and minor disasters. One thing seems certain: that the published estimates <u>never</u> include all the losses incurred. In other words, even in those years when spectacular losses have been reported, the actual totals of the losses caused by the floods have been in excess of the published amounts.

FREQUENCY AND RELATIVE SEVERITY OF FLOODS
ON THE MAITLAND RIVER, 1831-1954
BY DECADES

Period	Sharp Freshet	Heavy Flood	Severe Flood	Very Severe Flood	Totals
1831-40	1				1
1841-50		1			1
1851-60		1			1
1861-70		1	2		3
1871-80		1	1		2
1881-90	1		1	1	3
1891-1900				1	1
1901-10		1			1
1911-20		2	1	1	4
1921-30			2		2
1931-40	1	2			3
1941-50	1	5	1	1	8
1951-	4	2			6
Totals	8	15	8	4	35

MAITLAND RIVER

CHECK LIST OF FLOODS

1834 - February 22:
Lizars, R. & K., In the Days of the Canada Company (Toronto, 1896), page 226: (Near Goderich) - "The next morning, February 22nd of 1834, they watched the ice go out, the great cakes cracking and smashing in the wake of vanquished winter. The spring was early ..." Sharp freshet.

1852 - October 9 - 12:
McClary, William: Diary of Survey, Turnberry Township: Oct. 9: "the River Maitland is considerably swollen with the Rains". Oct. 12: "I crossed the River three times which was very troublesome in its present swollen state". Heavy flood.

1865 - March 17 - 20: March 21
Toronto Globe (from Goderich Signal, March 17th): Ben Millar bridge damaged; Piper's sawmill carried down river.
Toronto Globe, March 23 (from Goderich Signal, March 21st): damage to shipping in Goderich Harbour; a considerable quantity of lumber lost.
Toronto Globe, March 27 (from Goderich Signal): damage to fishing shanties, and to Platt's dam. Severe flood.

1868 - March 9:
Toronto Globe, March 11: Ice went out on the 9th, threatened vessels in Goderich Harbour, carried away fishermen's shanties, nearly the whole dock destroyed. Severe flood.

1868 - March 16 - 17:
Stratford Beacon, March 20: Waters at an unusual height at the beginning of the week (Monday, 16th, Tuesday, 17th), a farmer, 12th Con. of Elma, drowned in attempting to cross the river in a leaky canoe. Heavy flood.

1872 - April 8 - 9:
Toronto Globe, April 10 and 11: a considerable freshet at Goderich on the 8th, continued on the 9th, "overflowed the harbour". Heavy flood.

1873 - April 13 - 14:
Toronto Globe, April 15: considerable damage at Brussels, to bridges, mill-dams; two thousand saw-logs lost. Severe flood.

1883 - April 9 - 10
Toronto Globe, April 12: Hart's (Piper's) mill and dam at Goderich destroyed, loss, $15,000.
Listowel Banner, April 13: cellars flooded, bridges damaged, at Listowel. Severe flood.

MAITLAND FLOODS - 2

1883 - August 19:
Toronto Globe, August 21: Stratford Beacon, August 24: great destruction of mills, dams, bridges, and other property, at Listowel, Brussels, Wingham. Very severe.

1886 - April 15:
Toronto Globe, April 16: two persons drowned in a boat between Brussels and Sunshine. Sharp freshet.

1899 - April 11 - 12:
Toronto Globe, April 15: Listowel Standard, April 14; Wingham Times, April 14 and 21: man drowned at Gorrie; almost equal to the flood of August, 1883. Damage to bridges and dams, Listowel streets flooded, cellars filled, stores and houses damaged. Very severe.

1906 - January 22:
Toronto Globe, January 23: damage to a trestle at Goderich; Wingham Times, Wingham Advance, January 25: water over the highway south of Wingham, minor damage to a dam and flume. Heavy flood.

1912 - April 6:
Toronto Globe, April 8: Toronto Mail & Empire, April 8 & 9; Wingham Advance, April 11; Listowel Banner, April 11: "One of the worst floods in history"; much damage, at Listowel and Wingham, to dams, stores, houses, and other property. Very severe.

1913 - March 14:
Toronto Globe, March 15; Wingham Times, March 20; Wingham Advance, March 20: bridge at Harriston threatened; other damage to mills and stores; streets in Wingham flooded, one bridge swept away. Heavy flood.

1914 - March 23 - 29
Toronto Globe, March 31: Listowel Banner, April 2; Wingham Times, April 2: streets and mills flooded at Harriston; high water from "early in the week" (March 23) to Sunday, 29th, at Wingham. Heavy flood.

1917 - July 1:
Toronto Mail & Empire, July 2: flood at Listowel, "highest in many years", covering one of the business streets. Severe flood.

1929 - March 14 - 16
Stratford Beacon-Herald, March 15; Wingham Advance-Times, March 21: at Harriston, "one of the worst floods in the history of the town". Over the business streets at Listowel; streets, mills, houses flooded at Wingham. Severe flood.

MAITLAND FLOODS - 3

1929 - April 6 - 8:
Toronto Globe, April 8: Toronto Mail & Empire, April 8: Listowel Banner, April 11; Wingham Advance-Times, April 11: at Harriston, streets, homes, factories, and stores flooded; boy drowned at Wingham, river five feet above normal; dams destroyed at Fordwich and Wroxeter; dam washed out at Gorrie; Listowel escaped "with very little damage". Severe flood.

1932 - February 11 - 12:
Toronto Globe, February 13; Wingham Advance-Times, February 18: streets and stores flooded at Harriston; at Wingham, streets and a factory flooded. Heavy flood.

1934 - March 21:
Toronto Globe, March 22: at Goderich, the river rose 25 feet, damaging harbour works, threatening bridge abutments. Heavy flood.

1934 - April 2:
Toronto Globe, April 3: ice going out at Goderich. Sharp freshet.

1940 - April 8 - 9:
Toronto Globe & Mail, April 9: Stratford Beacon-Herald, April 8; Listowel Banner, April 11; Wingham Advance-Times, April 11: water 30 inches over highway at Wingham; roads and fields flooded near Atwood, and a bridge carried away. Heavy flood.

1943 - May 11 - 13:
Toronto Star, May 13 & 14: Wingham Advance-Times, May 13: water over the highway at Wingham, and some damage to a chopping mill; damage at Gorrie, Harriston, Wroxeter, to dams and bridges. Heavy flood.

1947 - April 5 - 6:
Toronto Globe & Mail, April 7 & 8: C.N.R. Report, Dec. 19, 1950 (flood date: April 5, 1947): property damage high at Wingham; C.N.R roadbed washed out at Henfryn. Severe flood.

1947 - April 11:
Toronto Globe & Mail, April 12: water over No. 4 Highway, near Wingham; washout between Listowel and Molesworth. Heavy flood.

1948 - March 19:
Toronto Globe & Mail, March 19, 20, & 22; Toronto Telegram, March 20 & 22; Toronto Star, March 20 & 22; Mitchell Advocate, March 25; Listowel Banner, March 25; C.N.R. Report, Dec. 19, 1950: great damage to harbour installations at Goderich; damage at Wingham estimated at $1,000,000; at Listowel, "Friday's flood was by far the greatest in Listowel's history". Very severe.

MAITLAND FLOODS - 4

1949 - December 22:
Toronto Globe & Mail, December 23: Toronto Telegram, December 23: at Wingham, Highway No. 4 flooded, some cellars flooded in the town. Heavy flood.

1950 - January 26:
Toronto Globe & Mail, January 27: break-up at Goderich, no damage. Sharp freshet.

1950 - April 4:
Toronto Globe & Mail, April 5 & 6: Listowel Banner, April 6: at Wingham, Highway No. 4 flooded, a dam threatened; at Listowel, water over the streets, buildings undermined and damaged. Heavy flood.

1951 - January 3:
Toronto Telegram, January 4: water over the floor of a bridge on Highway No. 4, south of Wingham. Heavy flood.

1951 - March 30:
Toronto Globe & Mail, March 31: Toronto Telegram, March 31: Toronto Star, March 31: at Wingham, water over highway and in cellars, four feet above normal. Sharp freshet.

1951 - April 25:
Toronto Globe & Mail, April 26: small streams near Ethel "pouring over their banks". Sharp freshet.

1953 - May 25-26:
Brussels Post, May 27: Listowel Banner, May 28: rivers and creek rising at Brussels; in Listowel, the river overflowed its banks in several places. Sharp freshet.

1953 - June 16-17:
Stratford Beacon-Herald, June 17: Seaforth News, June 18: the heavy rain raised the Maitland River to flood levels. Sharp freshet.

1954 - February 15 - March 1:
Kitchener-Waterloo Record, February 16: Stratford Beacon-Herald, February 23: Wingham Advance-Times, February 24: London Free Press, March 2: flood threats at Listowel and Wingham, ice jam at Listowel prevented by dynamite. Heavy flood.

CHAPTER 4

CAUSE OF FLOODS

The conditions which cause floods may be grouped in two classifications:

1. Geophysical, which are permanent
2. Climatic, which are variable

1. Geophysical

The lateral slopes to the stream channels are high and as may be seen from Tables 1 and 2 the gradients of the stream beds are also high in the headwater portions of both streams while those of the downstream portions are much lower. With these lower gradients the velocity is reduced, causing a corresponding rise in water levels and flooding of the low lands bordering the channels. There are no lakes or effective swamps to store water and delay run-off.

The above geophysical conditions produce a high rate of run-off; so much so that there can be little doubt that extensive flooding occurred even before the watershed was settled and denuded of its forest cover.

Since the object of drainage is to get rid of water sooner, there is also little doubt that the open drains and ditches on the farms necessary for good husbandry and those along the highways, together with the clearing of the land, have aggravated floods and have caused them to occur with greater severity and frequency. This applies particularly to the 40 square miles of drainage area above the Boyle drain.

2. Climatic

The magnitude of floods is variable and depends upon the climatic conditions at that time, such as the amount of snow cover, the temperature, (whether moderate or unseasonably high), the extent and duration of freezing periods, rain, the direction and velocity of the wind. The condition of the soil at the time, whether dry, saturated, frozen, or covered with ice is also important and to a large extent influences the rate and volume of run-off.

During an average winter 90 inches of snow falls on the headwater zone, and with an average winter temperature of 21 degrees (Fahrenheit) most of it may remain on the ground or be contained in the soil until the spring break-up. With heavy snow cover at the spring break-up and unseasonable high temperatures the snow-melt is rapid and the rate of run-off very high, with the result that at those places where the river channel is not large enough to contain these high flows it overflows and floods the low-lying areas. Flooding is particularly severe if there are no freezing intervals to check the snow-melt, and they may be increased further in magnitude by the untimely occurrence of rain or ice jams.

Spring floods in Southern Ontario are usually much greater and more frequent than the summer floods due to rain storms alone. However, the freak flood which occurred in August 1883 is the exception and is the greatest known flood for the watershed.

Aerial photograph showing the ice-clogged Middle Maitland River in flood, March, 1948. The structure in the centre of the photograph is the bridge on No. 4 Highway immediately south of Wingham.

CHAPTER 5

HYDROLOGY

1. Definition of Precipitation and Run-Off and a Description of Stream Flow

Precipitation is the condensation of moisture from the atmosphere which appears mainly in the form of rain and snow, and occasionally as hail, sleet or dew. Precipitation also occurs to a small extent from the condensation of fog.

Run-off is the amount of water a drainage area supplies to the open stream and, in a broad sense, is the excess of precipitation over evaporation, transpiration and deep seepage. The rate of run-off is expressed in cubic feet per second per square mile (c.s.m.).

Stream flow consists of surface flow and ground-water which is constantly entering the stream channel along its course. Surface flow is that portion of rainfall, melted snow and ice which reaches the stream channels directly by flowing over the ground surface. It is the component which forestry and land use practices strive to conserve by retaining or retarding this surface flow as much as possible by promoting deeper and more rapid percolation to the ground-water table. Surface flow also includes water falling on the surface of the stream and its tributaries, ponds, lakes and reservoirs. It usually constitutes the greater portion of stream flow and is responsible for the fluctuations in the stream flow. The ground-water flow (percolation) to the stream is going on continuously and supplies the stream flow during periods of drought. This portion is known as the base flow. Run-off is termed discharge or flow when it reaches a watercourse. Stream flow is expressed in cubic feet per second (c.f.s.), which is the volume of water that passes a particular section of stream or river in one second.

The percentage of spring run-off is usually very high and may approach 100 per cent. On the other hand the percentage of run-off during the summer months may be quite low, particularly after a long period of drought and depending upon the intensity and duration of the rainfall or storm. After a drought in July or August the run-off for an individual storm may be as low as 20 per cent or less, while in May, which is usually a wet month with the ground saturated, it may be over 65 per cent.

2. Measurement of Precipitation and Stream Flow

A reliable knowledge of the rate of run-off and stream flow is necessary for the solution of any hydraulic problem. This is derived from the records of:

(a) Meteorological stations
(b) Hydrometric stations.

(a) Meteorological Stations

Canada's network of meteorological stations is administered by the Meteorological Division of the Department of Transport. Monthly reports are published which show daily records of temperature, precipitation, atmospheric pressure, relative humidity, amount of cloud, sunshine duration and the velocity and the direction of wind. The stations are classified according to their equipment and personnel and quoting from their publications the classification is as follows:

"Class 1 - A station where standard equipment consists of a mercury barometer, wet, dry, maximum and minimum thermometers, anemometer, barograph and rain gauge, at most of these stations complete observations are taken four times daily at fixed synoptic hours, viz. 01.30, 07.30, 13.30, and 19.30 hours E.S.T. At the stations designated by 'T' the synoptic reports are immediately communicated by means of radio and telegraph to the teletype network linking all forecast offices in Canada.

(A) Indicates that the observations are taken at an airport.

(R) Indicates that the observations are taken at a radio range station at which there is no airport.

(S) Indicates that the observations are taken at a seaplane base.

Class II - A station where the equipment consists of a maximum and minimum thermometer and a rain gauge, although at a few stations the equipment is more extensive.

Class III - The meteorological equipment consists only of a rain gauge.

Class IIM or IIIM - A station in operation during the summer months only.

Chief Stations: - These are denoted by the letter 'F' indicating that these stations are Dominion Public Weather Offices and/or District Aviation Forecast Offices where forecasts are issued regularly.

At stations designated by "C" the equipment consists only of a sunshine recorder and/or an anemometer."

TABLE H-3

METEOROLOGICAL STATIONS AVAILABLE TO DETERMINE PRECIPITATION ON THE MAITLAND WATERSHED

Station	Class	Period of Records		Remarks
		From	To	
Goderich	II	1881 1929	1914 1953	
Lucknow	II	1886 1895	1892 1953	
Clifford	III	1951	1953	
Mount Forest	II	1883 1915	1887 1948	Discontinued
Listowel	II	1899 1913 1921 1951	1909 1918 1925 1953	
Stratford	II	1865 1893 1915	1888 1912 1953	
Mitchell	II	1949	1953	
Brucefield	II	1903 --	-- 1953	39 Years

The above table shows the meteorological stations that may be used to determine the amount of rain or snow that has fallen on any particular area of the watershed. Fair results may be obtained by simply averaging the precipitation of selected stations, but the Thiessen zoning method is better provided the stations are well located strategically. However, with the exception of the new station at Listowel the stations are too far from the Middle Maitland to use the latter method. A station at either Brussels or Blyth together with the one at Listowel would give good coverage for the whole of the Maitland Watershed.

(b) Hydrometric Gauges

(1) Their value in determining stream flow

Hydrometric gauges* record the run-off after it reaches the stream or river as flow. As stated previously the flow is expressed in terms of cubic feet per second (c.f.s.)of water which passes the section of the river at the gauge. These records combine all of the many† geophysical and meteorological factors which influence the volume and the rate of run-off. When reliable and continuous, the value of the records of a gauge increases with the years of operation. A gauge having 25 or more years of reliable and continuous records provides sufficient and the best data to determine the flow or rate of run-off for flood problems and, when dams and reservoirs are provided for conservation purposes, the amount of storage that is required to increase and sustain low flows.

The rate of run-off varies greatly over a watershed, and if reliable flows are to be determined at trouble areas, gauges should be installed at or near those places. If the watershed has one reliable and continuous long-term gauge strategically located, the other gauges, even if only in operation a few years, may be related "by ratios" to the long-term gauge and used to determine satisfactory flows for those places.

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* Hereafter called "gauges".

† At least 23 factors.

(2) Gauge installations and their rating curves

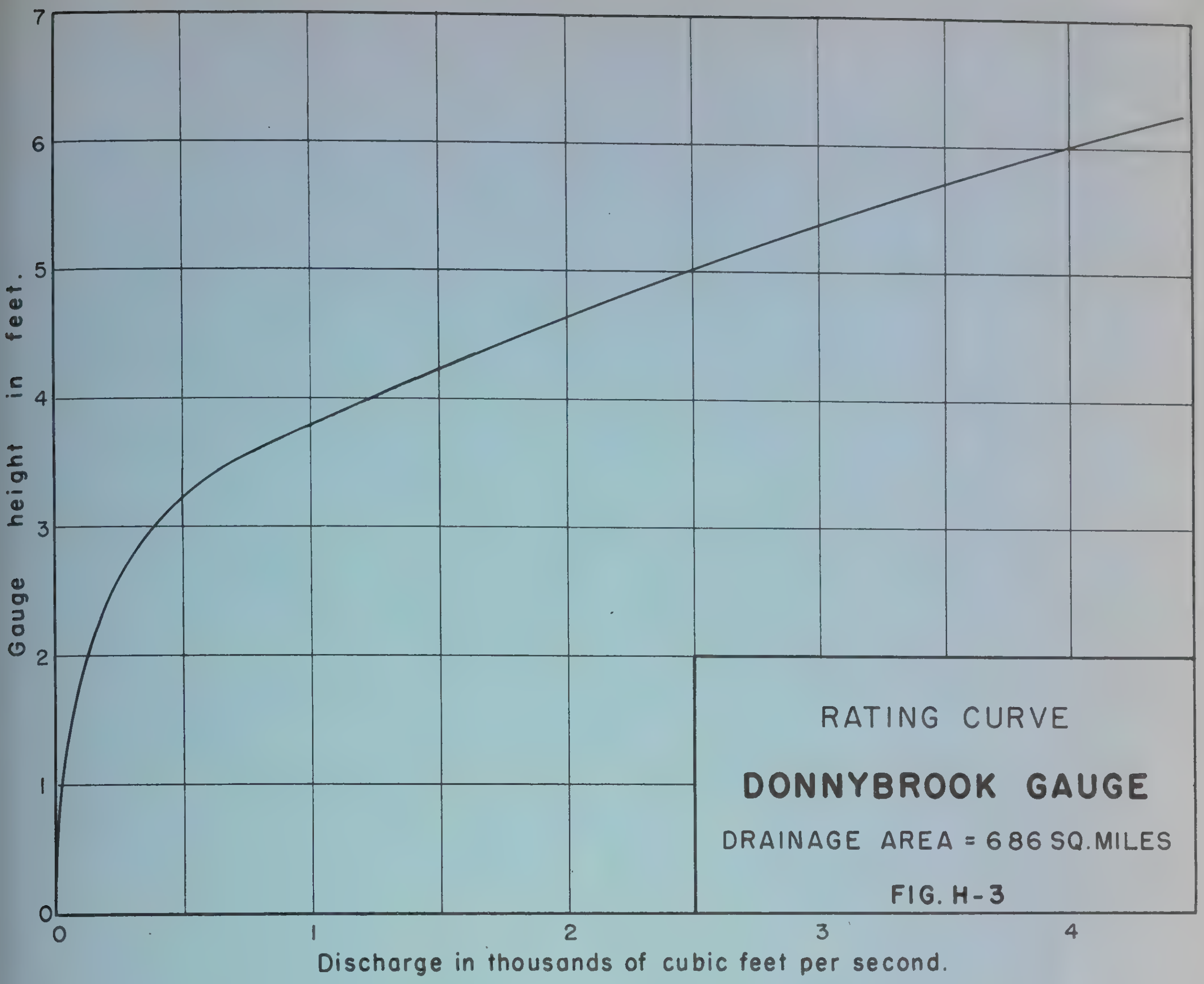
Gauges are installed at strategic points on the river and its tributaries. They consist of rods graduated in feet, tenths, and hundredths of a foot, affixed to bridges or other structures on a stretch of the river of uniform width with banks, if possible, above flood stages and where the banks or bed of the river are not subject to erosion and the flow is not affected by backwater.

The gauges are of two general types: staff gauges which are read manually once or twice daily and oftener during flood periods, and mechanically operated recorders that automatically record the water level stages by a continuous line on graph paper from which the water level may be determined for any time. These instruments require a special well and housing.

The river at the site of a gauge is cross-sectioned and the velocity measured by means of current meters with readings being taken at intervals across the section, at different depths at those intervals and at various times between low and high flow stages of the river. The average or mean discharge is determined for each of the various stages on the gauges. These measurements are repeated periodically in order to check any changes that may occur in discharge due to shifting and scouring of the river bed or any alteration of the original section. From these data a rating curve (Figs. H-3 and H-4) is prepared for the gauge whereby the discharge in c.f.s. may be read from the curve for any gauge height. For flood level stages, which are often difficult to measure, the curve can generally be extrapolated to provide a reliable estimate of the flow at those levels.

(3) The history of installations in Southern Ontario and gauges established on the Maitland Watershed

The systematic measurement of stream flow was begun in 1912 by the Ontario Hydro-Electric Power Commission,

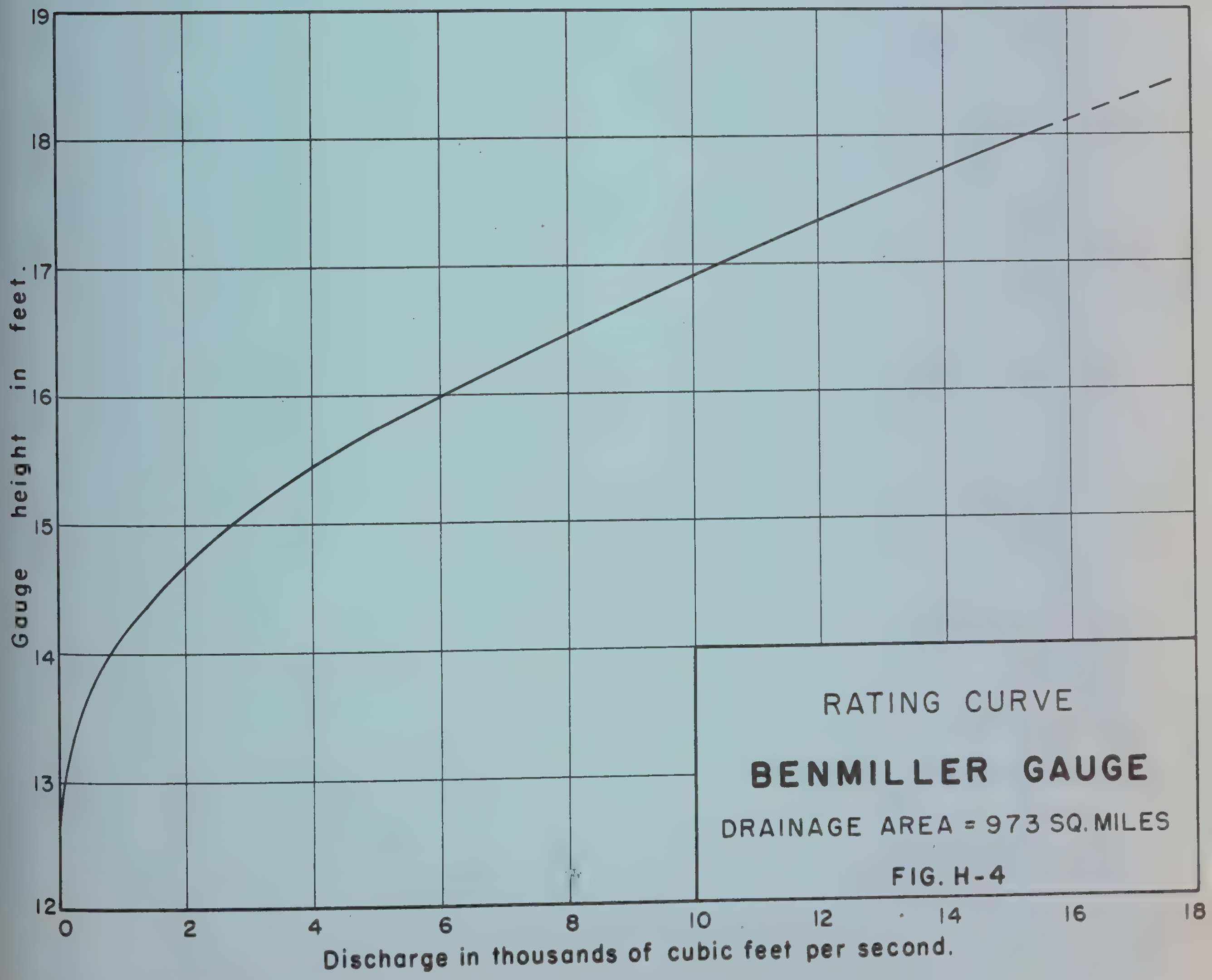


RATING CURVE

DONNYBROOK GAUGE

DRAINAGE AREA = 686 SQ. MILES

FIG. H-3



RATING CURVE

BENMILLER GAUGE

DRAINAGE AREA = 973 SQ. MILES

FIG. H-4

but as they were only interested in the development of hydro-electric power, gauging stations were usually established only on those streams indicating such potential and many were discontinued after a few years of operation. In 1919 after a co-operative agreement between the Hydro Commission and the then Department of the Interior, the Dominion Water and Power Bureau (now the Water Resources Division of the Department of Resources and Development, referred to hereafter as the "Bureau") assumed the responsibility of the hydrometric work. Unfortunately hydro-power development was still the motive, and the meterings were confined to those streams where such development appeared feasible. In 1944, when the Department of Planning and Development was established, it requested the Bureau to install gauges on many of the rivers in Southern Ontario which owing to their "flashy" nature had not been considered suitable for power and therefore had not been metered. In all about 30 new stations have been set up in Southern Ontario. Fig. H-1 shows the location of and Table H-4(a) the period of records and drainage areas of gauges on the Maitland Watershed.

TABLE H-4(a)

HYDROMETRIC GAUGES, DRAINAGE AREAS AND PERIOD OF RECORD

Gauge	River	Drainage Area Square Miles	Period of Record
Benmiller	Main Br.	972.52	1912 - 1917
Donnybrook	" "	686.00	1946 - 1953
Wingham (below Town)	" "	626.49	1953
Wingham (above Town)	" "	204.45	1953
Listowel	Middle Br.	30.33	1952 - 1953

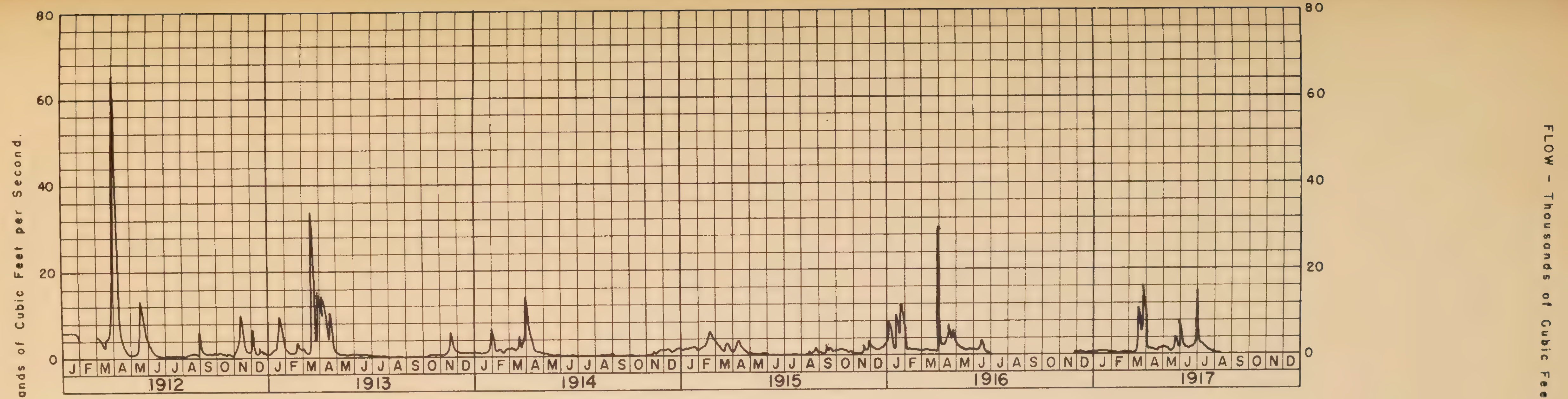
TABLE H-4(b)

DRAINAGE AREAS ABOVE VARIOUS LOCATIONS

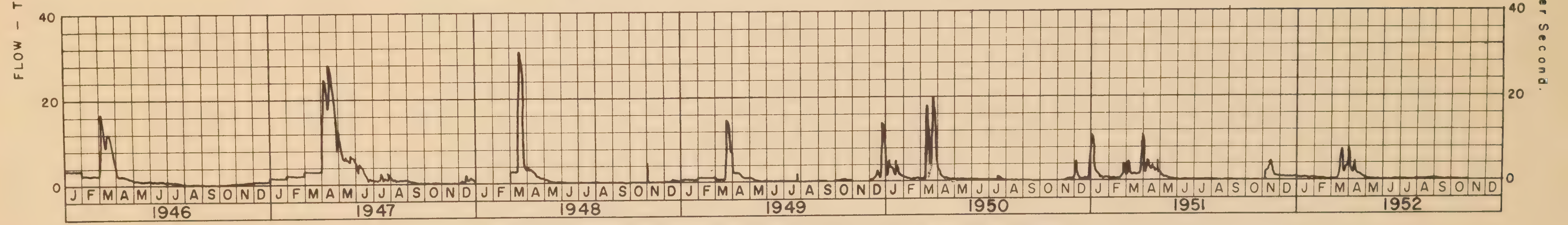
Location	River	Drainage Area Square Miles
Goderich	Main Br.	983.0
Wingham	" "	624.78
Brussels	Middle Br.	222.36
Listowel	" "	27.66
Harriston	Main Br.	26.64

The Benmiller gauge was in operation from 1912 to 1917 and then discontinued. Although it was well located strategically the records were not satisfactory and it was not renewed. In 1946 the Donnybrook gauge was set up in its stead. In 1952 a gauge was installed at Listowel and in 1953 two more gauges were set up in the vicinity of Wingham, one above and the other below the town. The Listowel and Wingham gauges, however, are in the course of being rated and no flow records are available as yet.

The rate of run-off over a watershed is variable, generally increasing progressively from the mouth of the river to its headwaters. Since the Benmiller and Donnybrook gauges are located well downstream and since their periods of records are short it will be about 10 years before definite rates of run-off can be determined for trouble areas on the Middle Maitland from gauge records. In the meantime, however, the Benmiller and Donnybrook gauges and the meteorological records will be used in the following section to determine rates of flow and run-off for floods at Listowel and the Boyle drain area. Although the values derived are only approximations, they are believed to be sufficiently reliable to determine the extent of measures required for flood relief. Hydrographs for all the years of record for the Benmiller and Donnybrook gauges are shown in Fig. H-5.



Gauge at BEN MILLER. Drainage Area 973 sq. miles.



Gauge at DONNYBROOK. Drainage Area 686 sq. miles.

HYDROGRAPHS

Mean daily flows plotted from records of the Water Resources Division, Department of Resources & Development, Ottawa.

FIG. H-5

3. <u>Rate of Run-off for Floods at Listowel and a Hypothetical Flood</u>

When practicable the policy of this Department is to provide protective measures for a flood 1-1/3 times the magnitude of the greatest known flood, which it is hoped, will not ever be exceeded. In any case, such a flood would be very rare and the cost of providing a greater degree of protection is not justified.

It is believed that one of the greatest floods in the history of the Province, and certainly the greatest for the Listowel area, contrarily was not a spring flood but one caused by a great summer storm which occurred over the head-waters of the Nith and Maitland Watersheds in August 1883. Fortunately, there are precipitation records at Listowel for this flood period which provide a means of estimating the magnitude of the resulting flood flow. Other great floods in this area in order of magnitude were the spring flood of April 1912, for which there are gauge records at Benmiller, and the spring flood of 1948 for which there are gauge records at Donnybrook. There was also a spring flood in 1899, but there are no hydrometric records for this flood and local records are not reliable.

The meteorological records of neighbouring stations for 1899 show that about 18 inches of snow had fallen during March of that year, but the amount of snow remaining on the ground at the time of the break-up and the period or duration of snow-melt is not indicated. It is therefore not possible to estimate the rate of run-off nor make a comparison with the other floods other than it is believed to have been less severe than the 1912 flood.

In the following sections approximate rates of flow and run-off at Listowel have been determined for the 1883, 1912, and 1948 floods and also rates for a hypothetical flood.

(a) <u>The 1883 Summer Flood</u>

From Table H-5 it will be seen that the month of July was a wet month, but it is unlikely that it had any effect on run-off for the August storm.

During the first 17 days in August only 0.51 inches of rain fell, 0.13 inches on the 3rd and 0.38 on the 12th and 13th; or 14 dry days preceded the storm. Temperature was not recorded, but it is quite probable that there was intense heat and evaporation during this dry period preceding the storm and the soil would be very dry. The records show that 1.42 inches fell on August 17th, 5.65 inches on the following day, or 6.25 inches for the 24-hour period from noon August 17 to noon the next day; and the intensity was such that 5.65 inches fell in 14 hours. A total of 7.07 inches fell in 48 hours of which <u>6.25</u> inches fell in 24 hours. This 24-hour rainstorm is the greatest ever recorded for Southern Ontario. It is believed that the difference of 0.82 inches occurring at the beginning of the storm would be sufficient to saturate the surface of the heavy clay soil and that the remaining 6.25 inches falling in 24 hours would approach total run-off.

The exact percentage of run-off cannot be determined but a close estimate can be made. Table H-6 shows calculated rates of flow and run-off for run-off percentages ranging from 75 per cent to 100 per cent for the storm. With a storm of this intensity it is believed that the run-off would be at least 90 per cent and probably as high as 95 per cent.

With 95 per cent run-off the peak flow through Listowel would be approximately 3366 c.f.s. with the peak rate of run-off for its drainage area $\frac{3366}{27.66}$ = 121.7 c.f.s./sq. mile

TABLE H-5

THE 1883 SUMMER FLOOD

(copied from Meteorological Records)

The Daily Precipitation, in inches, at Listowel, for the Months of July and August, 1883.

Day	July			August			Remarks
	A.M.	P.M.	Total	A.M.	P.M.	Total	
1		.03	.03				
2							
3		.42	.42	.05	.08	.13	
4		.06	.06				
5		T	T				
6							
7		1.09	1.09				
8							
9							
10		.09	.09				
11							
12		.77	.77		.32	.32	
13	.01		.01	.06		.06	
14							
15	.37	.03	.40				
16							
17							
18	.02		.02	.32	1.10	1.42	
19				5.15	.50	5.65	In 14 hrs. Water 2 ft. higher than ever known before
20				.06		.06	
21	T		T				
22	.93	.10	1.03	.02	.73	.75	
23	.04		.04				
24							
25							
26							
27	1.16	.65	1.81				
28				.09		.09	
29		.05	.05				
30		T	T				
31	.03		.03				
Total	2.56	3.29	5.85	5.75	2.73	8.48	

Observations apparently taken at noon and midnight
Temperatures etc. were not recorded
"T" denotes a trace of precipitation

TABLE H-6

APPROXIMATE RATES FOR 6.25 INCHES OF RAIN IN 24 HOURS FOR VARIOUS RUN-OFF PERCENTAGES

Percentage of Run-off	Run-off Above Listowel Acre Feet	Peak Run-off Above Listowel in C.F.S. per Sq. Mi.	Peak Flow through Listowel c.f.s.
75	6921	96.1	2659
80	7382	102.5	2836
85	7842	108.9	3012
90	8285	115.0	3182
95	8762	121.7	3366
100	9223	128.1	3543

(b) <u>The 1912 Spring Flood</u>

There are flow records for the Benmiller gauge covering the 1912 spring flood. However, this gauge is located on the main Maitland River just a few miles above Goderich and, as pointed out before, is too far away from the trouble areas of the Middle Branch to be of use in determining the flow at these areas by the usual methods. It can be used, however, in another approach to give approximate values which will be close enough for comparison with the 1883 flood.

It can be shown that if there are no freezing intervals to substantially check the snow melt or no ice jams to interrupt the flow during break-up and if the tributaries of the river all peak at about the same time, the hydrograph* for the flood period is approximately a triangle. With these conditions the flood period from base flow to base flow (the base of the triangle) is about the same for all floods, with the peak or apex of the triangle varying with the magnitude of the flood. The area of the triangle is equal to the volume of

* Definition of a hydrograph: See list of definitions at the beginning of the report.

run-off. If the volume of run-off and duration or base are known the altitude of the triangle or the peak flow is a simple calculation.

Other than at Listowel nothing is known as to the characteristics of the 1912 flood and the assumed provisos for the area between Listowel and Benmiller may or may not be true and the results affected accordingly. The rates for the Listowel drainage area, however, are believed to be reliable.

From historical records the 1912 flood interval at Listowel was from about 5 p.m., Good Friday, April 5, to about 8 p.m., Easter Sunday, April 7, a duration of flooding of 51 hours or 2.12 days. From base flow to base flow (the conduit about half full) the period was from about 3 p.m.,, Good Friday, to about 6 a.m., Easter Monday, an interval of 63 hours or 2.62 days.

At Benmiller the highest flows recorded were:

Saturday, April 6	41,600 c.f.s.
Easter Sunday, April 7	65,000 c.f.s.
Easter Monday, April 8	41,000 c.f.s.
Total for 3 days	147,700 c.f.s.

This is equivalent to:

$147,700 \times 1.98347 = \underline{292,958}$ acre feet of run-off for the Benmiller drainage area in 3 days.

Drainage area of Benmiller	972.52 sq. mi.
Drainage area of Listowel	27.66 " "

Proportioning the drainage areas and the time interval, the run-off for the Listowel drainage area for 2.62 days is:

$$292,958 \times \frac{27.66}{972.52} \times \frac{63}{72} = 7,276 \text{ acre feet.}$$

The snowfall over the Listowel drainage area for an average winter is 5.88 per cent greater than the Benmiller drainage area and on this basis the run-off at Listowel would therefore be $7,276 \times \frac{105.88}{100.00} = 7,704$ acre feet which is equivalent to 5.22 inches of water over the Listowel drainage area.

Considering the hydrograph as a triangle, the area being 7,704 acre feet and the base 63 hours, the peak flow through Listowel was approximately

$$\frac{7{,}704 \times 43{,}560}{63 \times 3{,}600} \times 2 = \underline{2{,}959} \text{ c.f.s.}$$

and the peak run-off $\frac{2{,}959}{27.66} = 107.0$ c.f.s./sq. mi.

(c) The 1948 Spring Flood

Using the Donnybrook gauge records, the same method has been followed below to determine the peak flow for the 1948 flood as for that of 1912.

The drainage area of the Donnybrook gauge equals 686.00 sq. mi.

The highest flows were	March 19	-	15,000 c.f.s.
	" 20	-	31,100 c.f.s.
	" 21	-	27,100 c.f.s.
Total for 3 days or 72 hours		-	73,200 c.f.s.

or 73,200 x 1.98347 = 145,190 acre feet.

By proportioning the Donnybrook and the Listowel drainage areas and time interval and providing for the extra snowfall for the Listowel area, the run-off for the Listowel drainage area was approximately:-

$$145{,}190 \times \frac{27.66}{686.00} \times \frac{105.88}{100.00} \times \frac{63}{72} = 5{,}423 \text{ acre feet, which is}$$

equivalent to 3.68 inches of water over the Listowel drainage area.

The peak flow through Listowel was approximately

$$\frac{5{,}423 \times 43{,}560}{63 \times 3{,}600} \times 2 = 2{,}083 \text{ c.f.s.}$$

and the peak run-off for the Listowel drainage area approximately

$$\frac{2{,}083}{27.66} = 75.3 \text{ c.f.s./sq. mi.}$$

(d) A Hypothetical Flood

The 1883 deluge was a freak flood and the cost of basing the hypothetical flood on that of 1883 would be prohibitive. Instead it is proposed to provide protection for a flood 1-1/3 times the magnitude of the great flood of 1912 which,

as is shown later, will be a little greater in magnitude than the 1883 summer flood.

A run-off graph* was prepared using the records of the Benmiller and Donnybrook gauges. For a flood 1-1/3 times the magnitude of the 1912 flood, the maximum mean daily flow at Donnybrook would be 55,880 c.f.s. or $\frac{55,880}{686}$ = 81.46 c.f.s./sq. mi. By Fuller's formula the peak rate of run-off above Donnybrook for the hypothetical flood would average 104.42 c.f.s./sq. mi.

As stated previously, the rate of run-off increases progressively towards the headwaters and therefore the rate of run-off for the area above Listowel would be greater than that determined for the Donnybrook area. The peak rates of run-off have been determined for the Donnybrook (85.68 c.f.s./sq. mi.) and Listowel (107.0 c.f.s./sq. mi.). The rate for the area above Listowel for the hypothetical flood may be determined by applying the ratio of these rates to the above hypothetical value for Donnybrook. On this basis the rate of run-off for the Listowel drainage area for the hypothetical flood is:

$104.42 \times \frac{107}{85.68} = 130.4$ c.f.s./sq. mi. which is equivalent to a peak flow through Listowel of 130.4 x 27.66 = 3,607 c.f.s. This flow is (3,607 - 3,366 =) 241 c.f.s. more than the determined peak flow for the 1883 flood.

4. Comments on the Determined Rates of Run-off

The rates of run-off for the Listowel flood have been determined rationally but should be considered as approximations only.

There was some apprehension in using Fuller's formula to convert maximum mean daily flows to momentary peak flows as this formula is not too reliable for these comparatively small drainage areas. It is more reliable when applied

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* The run-off graph is a graph prepared by plotting the maximum mean daily flow against the total volume of flood water for each flood.

to drainage areas of over 1,000 square miles. For instance, on the Grand Watershed there are five gauges in operation, and when comparisons were made with the recorded peaks for floods with their respective published maximum mean dailies raised to peaks by Fuller's formula, the difference between the recorded and calculated peak increased as the drainage area of the gauges decreased. It is suspected, therefore, that the calculated peaks for the floods at Listowel may be low.

Fuller's formula was not used to calculate the peak for the 1883 flood, but this rate may also be low. The volume of run-off is believed to be reliable, but the duration of this flood is not known and was assumed to be 63 hours or the same as the duration of the 1912 spring flood which was deduced from a press report of that flood. This may well be less for a summer flood, in which case a difference of each hour would increase the peak flow by about 54 c.f.s. or 2 c.f.s./sq. mi.

The reason for these comments is to point out that a run-off rate of 130 c.f.s./sq. mi. should be considered as the minimum protection for Listowel and that the provisions for the hypothetical flood may not be much greater than the 1912 flood. A few years of gauge records at Listowel will give firmer rates, but it will not make any difference in the channel improvement through the town, since it is not economically possible to reconstruct the conduit to take a flow greater than 3,600 c.f.s. or a run-off rate of 130 c.f.s./sq. mi.

The above flows together with their respective rates of run-off for Listowel are shown in Table H-7.

TABLE H-7

APPROXIMATE PEAK FLOWS AND RATES OF RUN-OFF FOR FLOODS AT LISTOWEL

Flood	Peak Flow c.f.s.	Peak Run-Off c.f.s. per Sq. Mi.
1883 Summer Flood	3,366	121.7
1912 Spring Flood	2,959	107.0
1948 " "	2,083	75.3
Hypothetical Flood (1-1/3 times 1912 Flood)	3,607	130.4

CHAPTER 6

THE LISTOWEL FLOOD AND LOW FLOW PROBLEM

1. Description of Conduit

The town of Listowel, with a population of 3,515, lies astride the upper reaches of the Middle Maitland. The river, which has a drainage area of 27.66 square miles at this point, is carried under the streets and buildings by a conduit or tunnel. The conduit was built over a period of years and is very irregular and varied in type of construction and state of repair.

The structure is 641 feet in overall length, with an open portion 62 feet long which divides it into upper and lower sections. In some parts there are lengths of concrete centre walls and piers, making a double channel, and at the downstream end of the lower section there is an extra wall, making three channels. Where there are no centre walls the width varies from 31 to 40 feet and the height from 8½ to 12 feet. In those parts with centre walls the channels vary from 14 to 21 feet in width and from 8 to 12 feet in height.

The bed of the conduit is rough boulder-strewn uneven clay. The superstructure or roof varies in construction and type of material used, one part being timber, another part reinforced concrete and the lower part steel beams. The roof is supported for the most part by concrete side and centre walls. The other type of wall is field stone masonry, and much of it is dilapidated and should be replaced. In many sections the footings of the walls are badly eroded and will soon need to be repaired or replaced.

At present the critical or controlling section is in the lower section directly under the north side of Main Street. It has been calculated that this section can only pass 1,700 c.f.s. safely. As pointed out above, this section has steel beams across the top, and it would be possible to raise these without disturbing the buildings above, and the critical flow section would then be at the entrance of the upper section.

There is a large amount of rubble and debris in the conduit and two rows of wooden piles in the upper section, which project up 3 feet above the bed. If the piles were removed, the debris cleaned out, the collapsed masonry wall section on the left* side of the conduit under Wallace Street repaired and some light grading done to level off the uneven clay bottom to a uniform grade, the capacity of the conduit could be increased to 2,000 c.f.s., or 300 c.f.s. greater than under existing conditions.

The above flows through the conduit and those determined later are approximate only. They have been carefully determined, but with the sharp and irregular bends, projections and other factors causing turbulence and resistance to flow, a model would have to be built and tests made to determine these flows accurately.

2. Behaviour of the 1948 Flood and Ice Jams

Figure H-6 shows the area inundated by the 1948 flood. Many cellars were flooded outside this area, however, by water backing up in the cellar drains. The following information concerning spring freshets, and the 1948 flood in particular, has been obtained from the residents.

At the peak of the average freshet the water at the entrance of the conduit is from 6 to 7 feet deep, leaving only about 2 feet clearance to the ceiling. With the 1948 flood, however, the water was 4½ feet deep on Main Street and about 12 feet above the bed at the entrance. The period during which the streets were flooded is believed to have been about 12 hours and that of the cellars about 62 hours. All but one of the residents interviewed said that there was no ice jam at the entrance, but there must have been ice choking the upper section, since the flood waters were pouring from the street and lanes into the open section behind Wallace Street and

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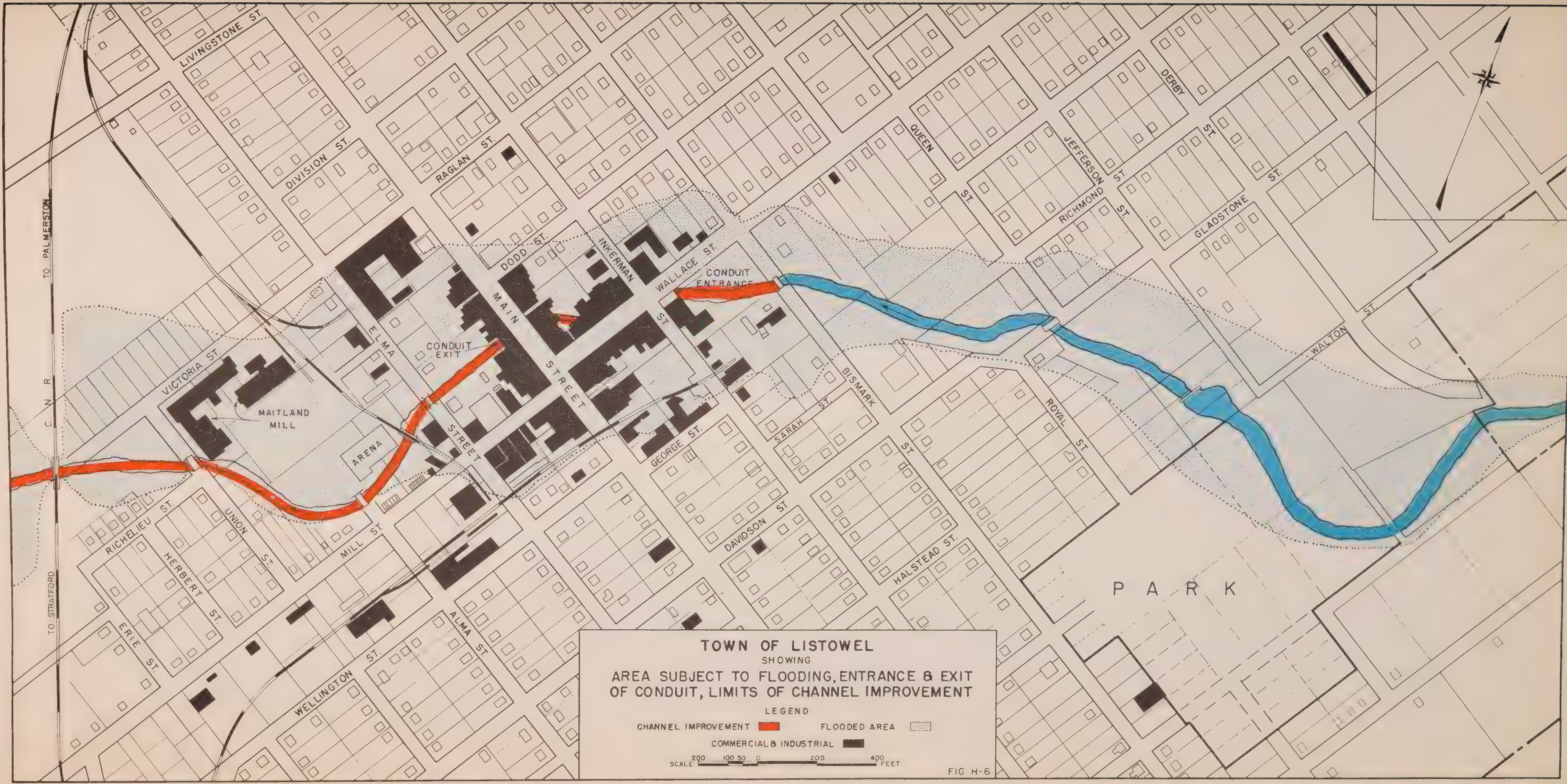
* The side on the left when looking downstream.


TOWN OF LISTOWEL
SHOWING
AREA SUBJECT TO FLOODING, ENTRANCE & EXIT
OF CONDUIT, LIMITS OF CHANNEL IMPROVEMENT
LEGEND
CHANNEL IMPROVEMENT
FLOODED AREA
COMMERCIAL & INDUSTRIAL
SCALE 200 100 50 0 200 400 FEET
FIG H-6
CONDUIT ENTRANCE
CONDUIT EXIT
MAITLAND MILL
ARENA
PARK
MAIN STREET
ELMA STREET
WALLACE ST.
INKERMAN ST
DODD ST.
RAGLAN ST.
DIVISION ST.
LIVINGSTONE ST.
VICTORIA ST.
QUEEN ST.
JEFFERSON ST.
RICHMOND ST.
DERBY ST.
GLADSTONE ST.
WALTON ST.
BISMARK ST.
SARAH ST.
GEORGE ST.
ROYAL ST.
DAVIDSON ST.
HALSTEAD ST.
MILL ST.
UNION ST.
HERBERT ST.
RICHELIEU ST.
ERIE ST.
ALMA ST.
WELLINGTON ST.
C N R
TO PALMERSTON
TO STRATFORD

flowing freely through the lower section. This condition would appear to be due to ice jamming the upper section since it has a larger opening than the lower section. There were no ice jams below the conduit and the water reached the top of the abutments, or a depth of 12 feet, at the Elma Street bridge. During other freshets ice has jammed in the open section and at the entrance and, contrary to the other evidence, one resident insists that there was an ice jam at the entrance during the 1948 flood and that he has a photograph of it. Ice jams may have aggravated the 1948 flood, but flooding would have occurred in any case due to the high flows of the period. Ice blocking the conduit could cause a flood with a normal or even a low run-off at the break-up.

Residents also stated that this ice did not come from the river at Listowel but broke up and came down from the pond above the town. That being the case, the ice hazard, if not eliminated, would be greatly reduced if the pond were drained before the freeze-up. It is vital that ice jams at the entrance be prevented and that upstream ice packs be broken before they reach the conduit to the extent that they will pass through freely. Floods cannot be prevented if ice jams in the conduit. This applies not only to the present conduit but also to the proposed improved conduit, which is described later. To break up the upstream ice jams or large ice packs it may be necessary to use explosives or thermite.

3. Remedial Measures

Proper land use and forestry practices will retard run-off and are a factor in flood control and to this end should be implemented. They will not, however, give sufficient relief and other measures are necessary. When good reservoir sites, which will impound the surplus run-off during flood periods and hold it for release during dry periods, are available and practicable, this method is the logical solution

to the flood problem. But where they are not available, then channel improvement through or around the trouble area is the only alternative.

There is only one reservoir site available above Listowel, and as this site would only control the run-off from about one-third of the total drainage area above the town, it would not be sufficient for adequate control. If the reservoir site were farther downstream so as to control about two-thirds of the drainage area and had about double the available storage capacity, then the flood and low flow problems at Listowel might be satisfied by reservoir control alone. The present channel through Listowel can be improved to provide sufficient opening which, barring ice jams at the entrance or within the conduit, will satisfy the flood problem but, as will be shown, reservoir control together with some channel improvement work has definite advantages over channel improvement alone and is to be preferred, since it aids both phases of the flow problem.

Three schemes, each of which provides for the hypothetical flood, are submitted.

Scheme A - Greater Channel Improvement

Scheme B - Listowel Dam and Reservoir with Lesser Channel Improvement

Scheme C - Listowel Dam and Reservoir with Spillway Diversion and Lesser Channel Improvement.

The following table summarizes the channel capacity flows and corresponding rates of run-off for the present channel and for the above schemes.

TABLE H-8

PEAK FLOWS AND RATES OF RUN-OFF AT LISTOWEL FOR THE PRESENT CHANNEL AND THE FLOOD CONTROL SCHEMES

Capacity of Listowel Conduit and Channel for	Flow c.f.s.	Rate c.s.m.
1. Present conditions	1,700±	61.4
2. With light grading	2,000±	72.3
3. With light grading and urgent repairs (items 1,2,3,6,8,9,16)*	2,500	90.4
4. Scheme A	3,690	133.4
Scheme A - if steel beams were not raised	3,240	117.1
5. Scheme B	2,343†	130.4
6. Scheme C (channel capacity same as B)	2,343	130.4

* Items shown in Table H-9.

† From uncontrolled area below dam (17.97 square miles).

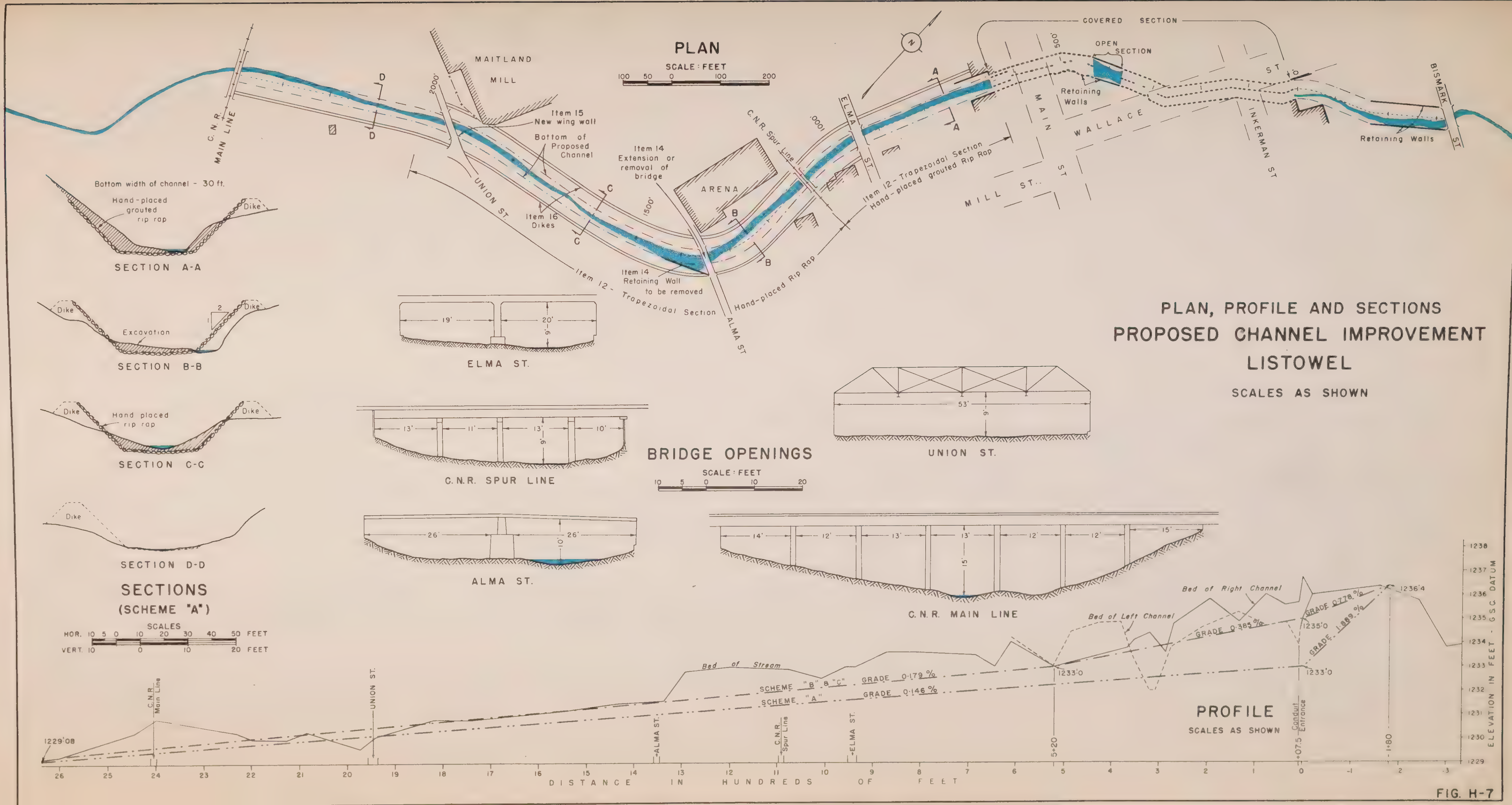
4. Scheme A - Greater Channel Improvement

Estimated cost $321,765.

(a) General Outline of the Scheme (Figs. H-7 and H-8)

This scheme provides for an increased channel opening through Listowel by regrading the present channel from a point 180 feet above the entrance through the conduit to a point 285 feet beyond the C.N.R. crossing below Union Street. The channel would have a uniform finished grade of 0.146 per cent except for the approach to the conduit which would be constructed to a grade of 1.889 per cent to meet the new grade at the entrance of the conduit.

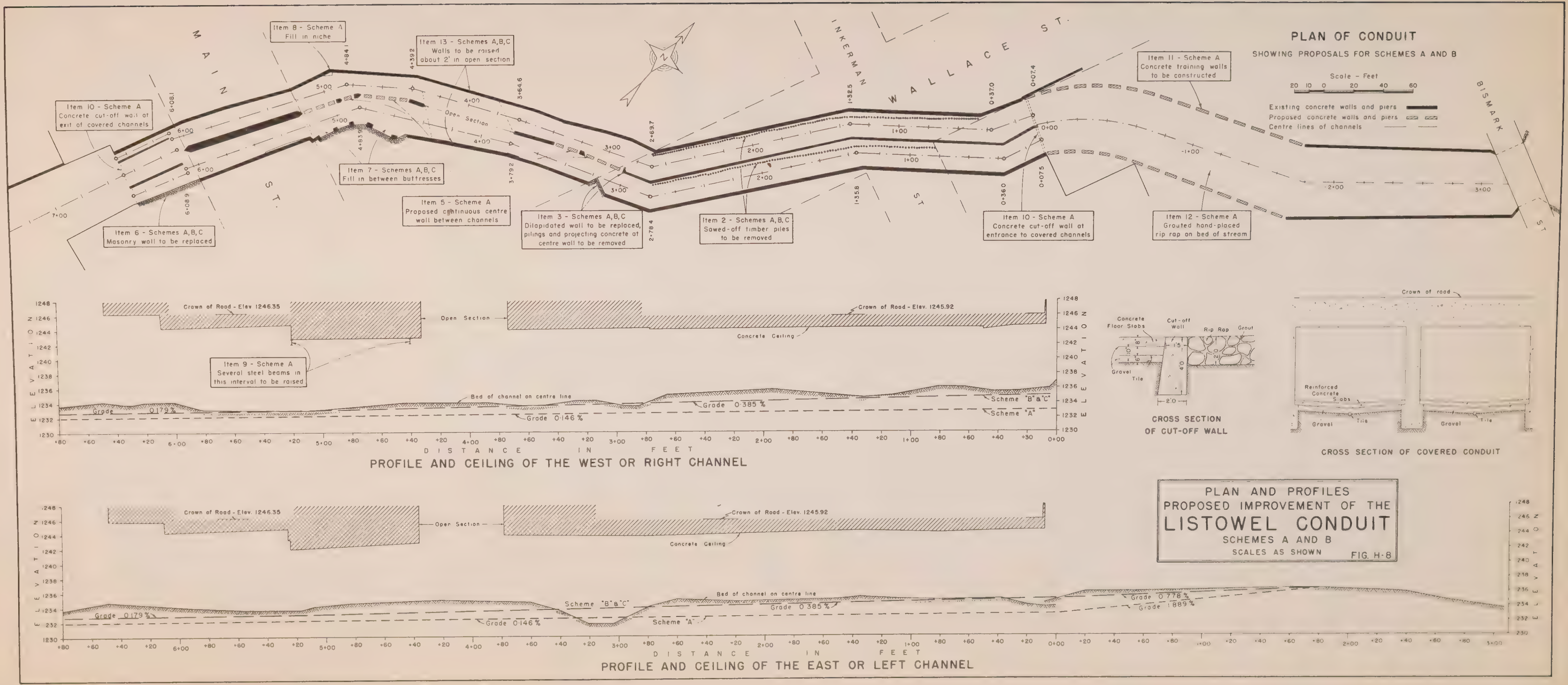
A twin conduit is proposed for each of the covered sections by filling in between the existing portions of centre walls and piers. The floors would be paved with reinforced concrete and would slope towards the centre of each channel in the form of a broad V in order to concentrate the low flows at the centre. The new grade line would increase the height of the conduit at the entrance by 2 feet and at the present critical section near Main Street by 1.1 feet.



PLAN, PROFILE AND SECTIONS PROPOSED CHANNEL IMPROVEMENT LISTOWEL

SCALES AS SHOWN

FIG. H-7



PLAN AND PROFILES
PROPOSED IMPROVEMENT OF THE
LISTOWEL CONDUIT
SCHEMES A AND B
SCALES AS SHOWN
FIG. H-8

In order to minimize turbulence and the possibility of ice jams at the entrance to the conduit, concrete training walls would be constructed to connect the existing retaining walls to the conduit. The bed of this section would be paved with hand-placed grouted rip-rap.

From the exit of the conduit to the railway siding just below Elma Street, trapezoidal channel with a 30-foot bottom width and 2:1 sides would be constructed. Owing to the high stream velocity at this point the channel bed and slopes would be lined with heavy hand-placed grouted rip-rap to prevent scouring.

From the railway siding to a point just below the Union Street bridge the channel would be trapezoidal in section as above, with ungrouted heavy hand-placed rip-rap. The remainder of the channel would be similar in cross-section but would not be lined.

The total length of the channel improvement would be 2,865 feet or a little over half a mile.

(b) <u>Items of the Scheme and Remarks</u>

The total excavation (1)* is approximately 13,862 cubic yards, 11,100 of which is in the open and 2,762 in the conduit. The cut averages from 1½ to 2 feet in depth and is believed to be all common excavation. These quantities are to sub-grade, which is 1½ feet below the finished grade for the conduit sections and 2 feet below for the rip-rapped open channel sections.

Obstructions such as the old wooden piles (2) in the upper section, the collapsed section of masonry wall on the left wall and the projection (3) on the end of the centre wall in the upper section, which obstruct the free passage of water and ice floes, would be removed.

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* (1), (2) etc. - Refer to the various items as they are set forth in the accompanying table of costs.

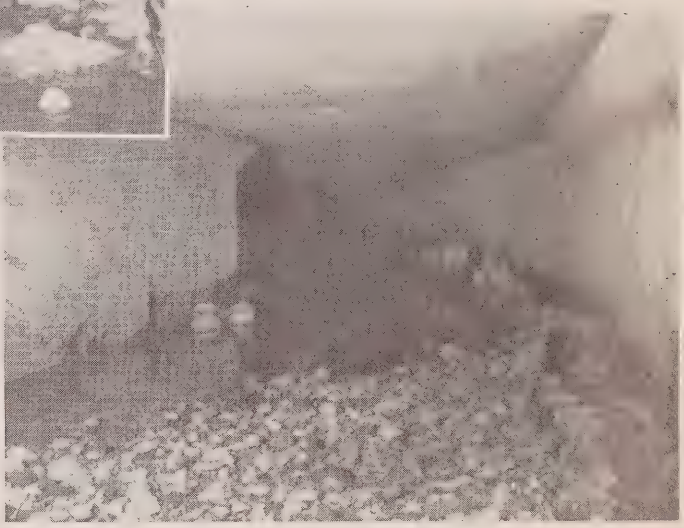
With the deep excavation necessary to provide the required opening, the present footing would be undermined, and new footings would be required (4). Also, as mentioned previously, there are many places where the present walls are crumbling away and are urgently in need of repair. These sections would be patched with concrete and made as smooth as possible to reduce the friction to a minimum.

In the covered sections of the conduit the lengths of centre walls and the piers would be joined to make the centre wall (5) continuous in each case. This would eliminate much of the flow turbulence, reduce the tendency for ice jams to form and increase the flow capacity of the channel. It would also facilitate the construction work in the conduit as either channel could then be sealed off while the work was in progress.

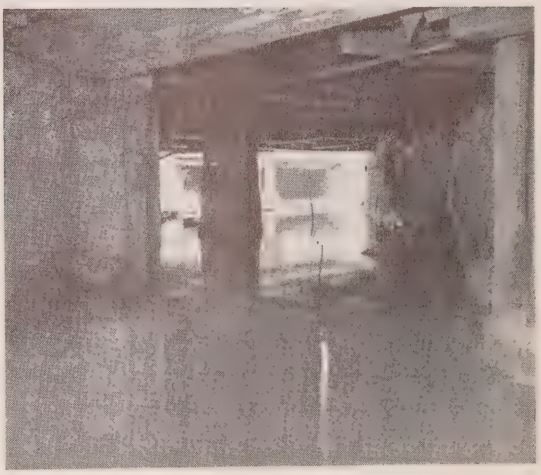
On the left side at the exit there is a 44-foot section of masonry field stone wall (6) which is disintegrating and in danger of collapsing. This would be replaced by a new concrete wall. Along this same wall, under the buildings fronting on the northerly side of Main Street, there are several buttresses which support the steel beams. These buttresses, projecting 3 feet out from the wall, cause extreme friction and turbulence and seriously reduce the capacity of the channel. To overcome this and aid the normal passage of the water, this section of wall would be made straight by filling in between the buttresses with reinforced concrete (7). Similarly, the niche on the right wall opposite this point would be filled in (8).

In the lower section the buildings fronting on the northerly side of Main Street are supported by steel beams and at present form the critical or controlling section of the conduit. The beams would be raised one foot (9). This work can be done without affecting the buildings above.

Entrance to West Channel. Note bottom obstructions and roof beams.



Upper end of West Channel under Wallace Street, showing rough floor and poor concrete.



Transition from concrete roof under Wallace Street to timber beams supporting buildings west of Wallace Street.

Steel beams supporting buildings north of Main Street. These form the critical flow section.

The floor of the conduit would be paved throughout with reinforced concrete over a gravel base. In order to concentrate the flow, the floor in each side of the conduit would be in the form of a broad V. Tile would be provided in gravel bed to take care of the subsurface drainage and cut-off walls would be constructed to a depth of 4 feet below the floor level to prevent the floor from being undermined (10).

At the entrance of the conduit, concrete training walls would be constructed to connect the existing walls to the conduit. On the left side a curved concrete wall 172 feet long and 12 feet high from the existing wall to the conduit and on the opposite side a similar wall 193 feet long would be required (11). The walls would guide the flow of water smoothly into the conduit, reducing the turbulence at this point and thus increasing the capacity of the channel. The walls would also help to prevent ice from collecting at the entrance.

As the velocity for the design flood flow would be about 7 miles per hour, it would be necessary to protect the open channel sections with heavy rip-rap in order to prevent erosion. It is important that the rip-rap should be carefully placed to reduce friction losses. This is particularly important for the sections below the conduit, as otherwise the water might be backed up into the conduit. In order to comply with the hydraulic calculations, the rip-rap must be so placed and grouted that the projections will not exceed $1\frac{1}{2}$ inches.

The bed of the channel between the training walls would be paved with heavy hand-placed grouted rip-rap. The bottom and sides of the trapezoidal channel from the exit of the conduit to the spur line below Elma Street would be similarly paved (12a) while the channel to a point just below Union Street would be paved with heavy hand-placed ungrouted rip-rap (12b). No lining has been provided for the remainder of the channel.

The walls along the open section of the conduit behind the stores fronting on Main and Wallace Streets would be raised 2 feet to prevent the water from overflowing at this point when the conduit is running full (13).

The Alma Street bridge and the retaining wall on the left side immediately below the bridge form an obstruction and would be removed to permit freer flow at this point (14). Apparently this bridge serves as an access to the arena and park area, but a right-of-way could be secured on the north side to provide access to this area.

Farther down the channel, the north-easterly wing-wall and drain outlet at Union Street, which also obstruct the flow, would be modified to suit the alignment of the new channel (15).

With all of the above improvements, there would still be some flooding of the low-lying lands along the open channel section below the conduit and thus dikes are required for this area. The right bank dike would start just below the exit of the conduit and end at Union Street. This dike would run parallel to the channel and would be about 1,225 feet long. The left bank dike would start at Elma Street, follow the left bank and tie into the C.N.R. embankment below Union Street. Length of this dike would be about 1,440 feet.

The duration of the peak flow would not be long, and therefore it would not be necessary to provide for local drainage on the land side of the dikes. Also, impervious cores would not be required and the dikes would be built with the material excavated from the channel. The dikes would have side slopes of 2:1 on the river side and 1½:1 on the land side, and a top width of not less than 6 feet. The top of the dikes would be 11.0 feet above the finished grade of the channel, which would provide 1.7 feet of freeboard for the hypothetical or design flood flow.

The items of work, together with their costs and the total cost of the scheme, are shown in Table H-9.

Maitland River upstream from covered channel to Bismark Street Bridge.

C.N.R. spur line and Elma Street bridges below conduit.

Alma Street Bridge and training wall.

5. Scheme B - Listowel Dam and Reservoir with Lesser Channel Improvement.

Estimated cost $367,016.

(a) General Outline of Scheme

Flood control for Listowel in this scheme is by means of an upstream dam and reservoir together with a minimum amount of necessary work in the conduit and stream channel through the town.

Table H-8 shows that with the debris in the conduit cleaned out, some light grading and urgent repairs made to the walls, the conduit will pass 2,500 c.f.s. which together with the dam and reservoir would satisfy the problem.

The only reservoir site above Listowel is at the headwaters of the Middle Maitland (Fig. H-2) where it only controls a drainage area of 9.69 square miles leaving an uncontrolled run-off area above Listowel of 17.97 square miles or about 2/3 of the total area. The determined peak rate for the hypothetical flood (Table H-7) is 130.4 c.f.s./sq. mi. Assuming that the gates of the proposed dam would be closed for the flood period the run-off from the uncontrolled area and the resulting flow through Listowel would be 17.97 x 130.4 = 2,343 c.f.s.

In Chapter 5, using the records of the Benmiller gauge a run-off above Listowel of 7,704 acre feet over a 2.62-day period was determined for the 1912 flood. The run-off for the hypothetical flood would therefore be $7{,}704 \times \frac{4}{3} = 10{,}272$ acre feet. By proportion the inflow into the reservoir for the hypothetical flood would be $10{,}272 \times \frac{9.69}{27.66} = 3{,}599$ acre feet.

The reservoir would have a holding capacity of 5,000 acre feet and a surcharge capacity of 2,000 acre feet, or a total capacity of 7,000 acre feet, and would be capable of taking an inflow of $\frac{7{,}000}{3{,}599} = 1.94$ or about twice the run-off of the 1912 flood for a 2.62-day period. By the same reasoning the inflow into the reservoir for a 5-day period (2 days before

and 2 days after peak day) for the hypothetical flood would be 4,807 acre feet, and therefore if the reservoir were empty the flow from this area could be cut off entirely for the duration of the flood period.

(b) Lesser Channel Improvement (Fig. H-7)

In order that the conduit and the open channels at Listowel may discharge the run-off from the area below the proposed dam, some channel improvement work and repairs are necessary. This would include light grading, removing obstructions which impede the flow, and replacing or repairing those dilapidated sections of the walls which are unsafe. Some of the items for this work are similar to those in Scheme A, but the costs may vary depending upon the quantity of work in each case.

The light grading would be confined to cleaning out the debris and levelling off the existing lumps and sags in the bed of the channel (1). The grading would cover the same sections as that for Scheme A but the grades would differ as shown in Figs. H-7 and H-8.

The timber piles (2) and other obstructions (3) would be removed to provide for the freer passage of the flood flows. With the limited excavation in the conduit the present footings would not be disturbed and only such repairs as are necessary for the structural soundness of the conduit would be made to the existing footings and walls (4C) (6).

The buttresses and small niche in the lower section just above Main Street would be filled in with reinforced concrete to reduce the friction at this point (7). The side walls at the open section behind Main and Wallace Streets would be raised 2 feet to provide adequate channel section (13).

In Scheme A the dikes would be constructed to an elevation 11.0 feet above the bed of the channel, but with the lesser flow of this scheme the dikes could be reduced to a height of 8.8 feet above the bed and still provide 1.7 feet

of freeboard. However, there will be a surplus of excavated material and the dikes could be raised or widened if desirable (16).

The estimated cost of the channel improvement work is $24,544.

(c) <u>Description and Cost of the Listowel Dam</u> (17)

The damsite lies astride Lots 13 and 14, Concession III of the Township of Wallace (Fig. H-9).

An earth fill dam with a concrete spillway section consisting of 3 stop log sections, each 6 feet wide and 12 feet high, is proposed. The stop log sections would be seated on a concrete spillway the crest of which would be 18 feet above the foot of the dam. In order to regulate summer flow and also to prevent the reservoir from filling up to the stop log level too quickly, the dam would be fitted with two 5 x 5 foot steel gates located at the bottom of the spillway section.

At maximum water level the stop log section would discharge 3,600 c.f.s. and the gates 1,250 c.f.s. or a total of 4,850 c.f.s.

To prevent disaster, a dam must be able to discharge the inflow of any conceivable flood. The magnitude of a maximum flood is not known, but the above discharge capacity is believed to be well on the safe side since a discharge from the dam of 4,850 c.f.s. is equivalent to a run-off rate of $\frac{4,850}{9.69} = 500.5$ c.f.s./sq. mi. The determined peak rate of run-off for the 1912 flood was approximately 107.0 c.f.s./sq. mi. The dam, therefore, would discharge a flood $\frac{500.5}{107} = 4.68$ times the magnitude of the 1912 flood and $\frac{500.5}{121.7} = 4.11$ times the 1883 flood, which is the greatest flood on record for this area.

The dam would be about 1,400 feet long with a concrete spillway opening of about 26 feet. The top of the dam would be at elevation 1,305.0 or 35 feet above the bed cf the

Proposed Listowel Dam site—Lot 13, Con. III, Township of Wallace.

A large part of the Listowel Reservoir will cover only low-grade pasture and willow scrub such as this.

stream which is at elevation 1270.0. No subsurface exploration has been made and for the purpose of estimating the cost, a depth of 10 feet for the footings of the concrete spillway section has been assumed. Thus the total height of the concrete spillway section would be 45 feet.

The holding storage elevation would be 1,300.0 to give a depth of water at the dam of 30 feet. The crest of the concrete overflow spillway is at elevation 1,288.0 or 18 feet above the foot of the dam. The estimated cost of the dam is $226,600.

(d) Description and Cost of the Listowel Reservoir (18)

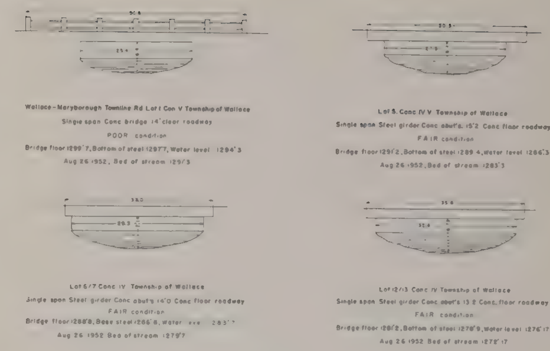
The Reservoir would flood parts of the following lots in the Township of Wallace, County of Perth:

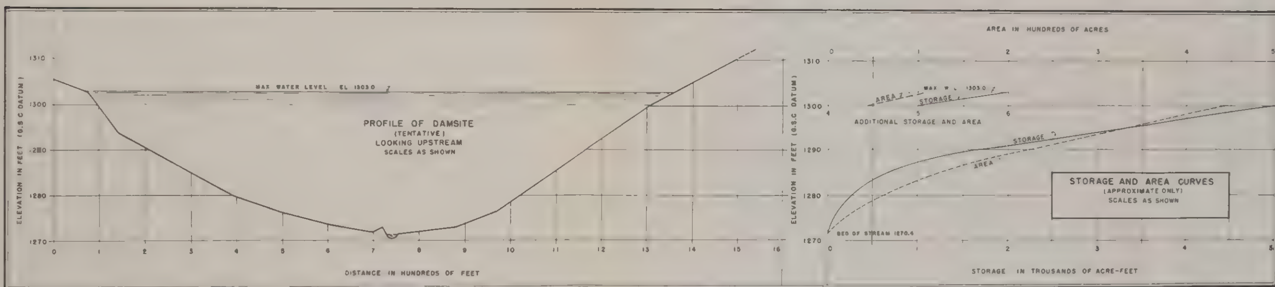
Lots 13 and 14	Concession	III
Lots 4 to 13 inclusive	"	IV
Lots 1 to 5 inclusive	"	V

and in Maryborough Township, County of Wellington, Lots 1 to 3 inclusive.

The storage capacity of the reservoir at elevation 1,300.0 would be 5,000 acre feet with a surface area of 445 acres. At this elevation the reservoir would be 4.54 miles long with an average width of 810 feet. The capacity at the maximum or surcharge water level, elevation 1,303.0, would be 7,000 acre feet and the surface area approximately 513 acres. Of the 445 acres that would be flooded 53% lies in the marshy flood plain of the stream. The land is largely covered with willow scrub with some scattered scrub elm, and provides at best only low-grade pasture. In the remaining land, only about 5 acres can be classed as wooded. Approximately 84 acres or 19% is in crop; and the remaining 121 acres or 27% is in hay or pasture.

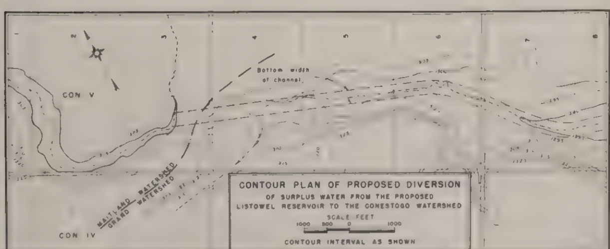
Four bridges would be submerged namely, the crossings on the side roads between Lots 12 and 13, Concession IV; between Lots 6 and 7, Concession IV; the Town Line and





BENCH MARKS

NO	DESCRIPTION	LOCATION	ELEV
M-4-1	"+" on S Corner of S.E wingwall of bridge over Middle Maitland R.	Lot 12/13, Con III/IV Township Wallace	280.92
M-4-2	N End of channel iron forming West curb of bridge over Middle Maitland River	Lot 6/7, Con IV Township Wallace	288 [illegible]
M-4-3	Top of conc centre post of west guard rail of Settler's bridge over Middle Maitland River	Maryborough — Wallace Townline Conc V	303.54
M-4-4	"X" on N E Corner of N E wingwall of bridge over Middle Maitland River	Lot 5, Conc. IV/V Township of Wallace	1291.16



MIDDLE MAITLAND WATERSHED

LISTOWEL RESERVOIR

TOWNSHIPS of WALLACE & MARYBOROUGH

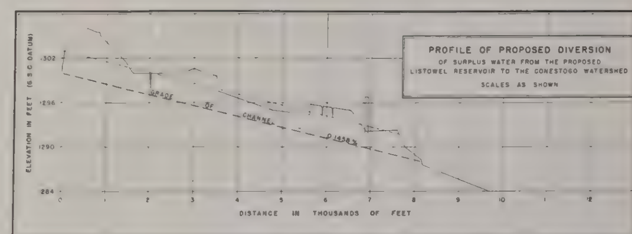
COUNTIES OF PERTH & WELLINGTON

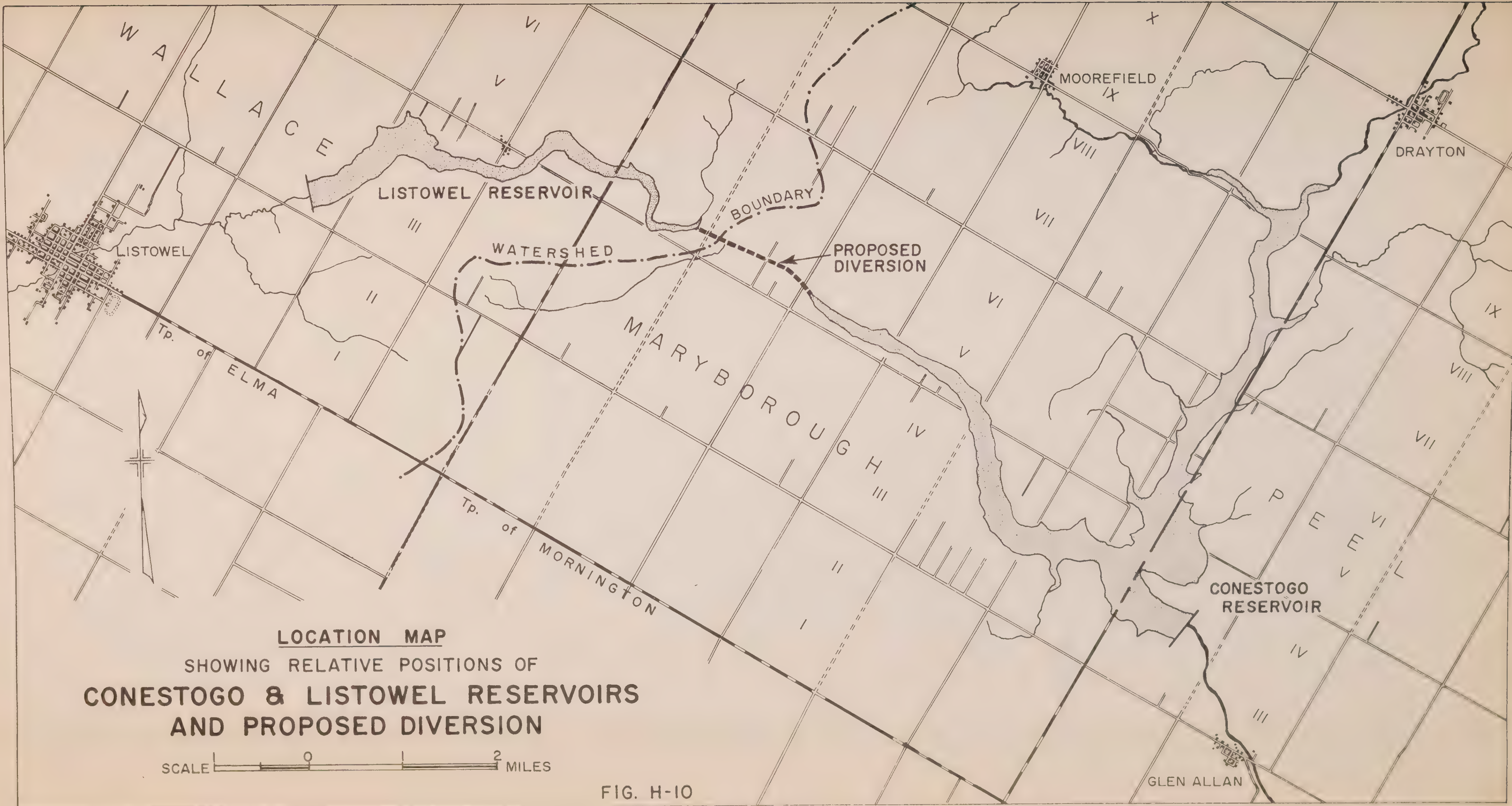
ONTARIO DEPT OF PLANNING AND DEVELOPMENT

CONSERVATION BRANCH

HON W K WARRENDER - MINISTER

FIG. H-9





LOCATION MAP

SHOWING RELATIVE POSITIONS OF

CONESTOGO & LISTOWEL RESERVOIRS AND PROPOSED DIVERSION

FIG. H-10

0.1458 per cent or about 7.7 feet to the mile. The maximum depth of water in the channel would be 3 feet, and at this depth the calculated discharge would be 2,985 c.f.s. with a maximum velocity of 3.25 feet per second which would not cause any serious erosion. Except during flood periods the channel would be dry and could be used for pasture. The cross-section of the channel would be flat with a ditch along its centre line for lateral drainage.

The side road between Lots 3 and 4, Concession V of the Township of Maryborough is not surfaced and is only used locally. A bridge would not be necessary since the channel would be dry except for a few days during the rare flood periods, and a short strip of pavement for the road crossing would be sufficient.

The excavation amounts to 593,100 cubic yards. Of this it is estimated that there would be 6 inches or 38,500 cu. yds. of top soil which would be stockpiled and later spread over the finished channel, consolidated and seeded to grass. The remainder of the material, if suitable, would be more than that required to build the dam. The haul, however, would average 5½ miles and it would probably be cheaper therefore to dispose of it by constructing embankments along the sides of the channel.

The estimated cost of the spillway diversion is $202,765 and the total cost of the scheme is $600,195.

The items of work for each of the schemes together with their individual costs and the total costs for each scheme are shown in Table H-9.

7. The Effect of the Spillway Diversion on Sewage Disposal and Increased Summer Flow

About ninety per cent of the town is serviced by septic tanks which overflow into the sewers and thence empty into the conduit, while many of the buildings over the conduit empty raw sewage directly into the channel. This is

TABLE H-9

COMPARATIVE SUMMARY OF COSTS OF SCHEMES A, B, AND C.

Item No.	Description	Costs for Scheme A	Costs for Scheme B	Costs for Scheme C
1	Regrading, common excavation	$ 22,148	$ 6,144	$ 6,144
2	Removal of timber piles	500	500	500
3	Removal of obstructions under Wallace St. Sta. 3+00			
	(a) New concrete wall; L.side	1,895	1,895	1,895
	(b) Centre wall piling & projecting concrete	500	500	500
4	Wall footings			
	(a) Sidewalls: Removal of old footings and placing of concrete	48,900		
	(b) Centre wall; placing of concrete	24,788		
	(c) Patching walls & footings with concrete	2,000	4,000	4,000
5	Continuous concrete centre wall	9,234		
6	New concrete wall, left side; Stas. 6+00 to 6+50	4,710	5,228	5,228
7	Buttresses; L. wall; Sta. 4+50 to 5+20. Fill in with concrete	3,925	5,552	5,552
8	Fill in niche with concrete; R wall, Sta. 4+80 to 5+10	1,162		
9	Raise ceiling beams 1 foot Sta. 4+40 to 5+20	10,000		
10	(a) Concrete floor through conduit	32,204		
	(b) Concrete cut-off walls at conduit's entrance & exit	1,160		
11	Concrete training walls; approach	36,500		
12	Rip-rap hand-placed			
	(a) Grouted approach 180'	7,920		
	(b) Not grouted - Sta 11+00 to 20+00	35,000		
	(c) Grouted; 6+50 to 11+00	35,025		
13	Raise side walls 2'; open section	725	725	725
14	Removal of Alma St. Bridge and the wall below	500		
15	New wing wall - Union St. Bridge	1,000		
16	Dikes, Cost included in Item 1	-	-	-
17	Construction of Listowel Dam		226,600	226,600
18	Listowel Reservoir; Land bridges and relocation of road		68,000	68,000
19	Spillway diversion into Conestogo			202,765
	Total Cost of Construction	$279,796	$319,144	$521,909
	Engineering & Contingencies, 15%	41,969	47,872	78,286
	Total Cost of Scheme	$321,765	$367,016	$600,195

a very unsanitary condition. The odour is always noticeable and in the spring, summer and fall it varies from objectionable when there is some flow in the channel to a stench when the channel is almost dry. The town is badly in need of a proper sewage disposal plant and while reservoir storage would provide a sustained increased flow through Listowel and would greatly improve existing conditions, sewage treatment would still be necessary.

The reservoir, however, is not large enough to function for both flood control and at the same time maintain adequate storage in the reservoir for summer flow. During the spring freshet there would be the problem of filling the reservoir and, at the same time, preventing a flood. There would always be the risk of unpredictable high temperatures and rain during or immediately following the run-off period and of being caught with the reservoir prematurely full.

Immediately after the spring run-off was over, the water level of the reservoir would be lowered as quickly as possible to a stage that would provide space for the inflow from any storm that might occur thereafter. A freak storm such as occurred in 1883 is unlikely but is possible and if flood risks after the spring break-up are to be avoided, reservoir space should be made available to receive the inflow of a similar storm. This for the 1883 storm would amount to an estimated 3,070 acre feet. With allowance for dead storage this would leave at most only 2,000 acre feet of storage to increase the low flows.

With 2,000 acre feet for an average summer period June 1st to September 20th, the mean daily discharge from the dam would only be 8 c.f.s. and for the year round, about 3 c.f.s. The drawdown usually begins about June 1st and if, on the other hand, the reservoir were full at that time it could supply an average daily discharge of 21 c.f.s. during the above summer period or 8 c.f.s. throughout the year. These

discharges are for an average year for which an allowance has been made for loss by evaporation during the summer and ice in the reservoir during the winter.

For such years, when at the time of the break-up the snow cover is not heavy and a light run-off is expected, in order to fill the reservoir it might be necessary to practically close the dam for the whole of the spring run-off period, discharging only enough water to dilute the town's effluent; and for a year of average snow cover perhaps only for part of the period. In a lean year it might not fill at all during the run-off period, or even during an average year if the controller of the dam were overly cautious and waited too long before closing off the dam.

Listowel needs an increase of low flows for the year round and the greatest use possible should be made of the reservoir. To sustain a minimum flow of 8 c.f.s. the year round, the reservoir would have to be full at the beginning of the drawdown period, viz., about the first of June, with no space being reserved for subsequent storms. A full reservoir at this time would give little or no flood protection against summer storms unless the surplus inflow could be taken care of. This is possible if the Grand Valley Conservation Authority and the Grand River Conservation Commission would agree to an overflow spillway channel to carry the surplus inflow from the Listowel Reservoir drainage area over to the Conestogo Reservoir when the latter comes into operation.

If this could be arranged, Scheme "B" would satisfy the Listowel flood problem and the sustained increase in low flows would stimulate the Middle Branch throughout its course. Also each spring there would not be the unpredictable and harassing problem, for the dam controller, of filling the reservoir and at the same time preventing flooding.

8. The Effect of a Hypothetical Rainstorm on the Spillway Diversion

The Listowel Reservoir drainage area (9.69 sq. mi.) is small compared to that of the Conestogo Dam (219.47 sq. mi.) and quite small compared to that of Galt (1,357.86 sq. mi.) the key flood control centre for the Grand Watershed.

Expressed in percentage the Listowel Reservoir drainage area is $\frac{9.69}{219.47} \times 100 = 4.4\%$ of the Conestogo Dam drainage area and only $\frac{9.69}{1,357.86} \times 100 = 0.7\%$ that above Galt.

For normal spring run-off and later rains the amount of inflow diverted would be less than 4.4 per cent of the total Conestogo inflow and would be insignificant, but with a major storm occurring when both reservoirs were full it might create a flood hazard. The peak rate of run-off for the Listowel Dam and Conestogo Dam drainage areas for the hypothetical flood is about the same, viz. 130 c.f.s. per sq. mi., and it is reasonable to assume that it might occur simultaneously on both watersheds.

It was shown earlier that with the dam closed tightly for 5 days - 2 days before and 2 days after peak day - the inflow into the reservoir would be approximately 4,800 acre feet and by coincidence brim-full if there was 200 acre feet of dead storage in the reservoir to begin with. It would not be possible to anticipate peak day exactly, but with snow surveys and good weather reports it should be possible to determine it within two days for the Listowel drainage area. If the dam were closed say 4 days before and 2 days after peak day, the flow of this 7-day interval would be more than the reservoir could hold. If the reservoir were full to the maximum holding level and the conduit only partially full, then it might be possible to hold the reservoir at this level by discharging the inflow into the reservoir, provided the combined flow from the reservoir and the uncontrolled area did not exceed the

capacity of the conduit. If, however, the conduit were already full, then in order not to flood Listowel the dam would be closed and the surplus water allowed to escape via the proposed overflow channel into the Conestogo Reservoir. This is the behaviour to be expected for the hypothetical spring flood occurring after the dam has been closed and filled prematurely.

It has been shown that with efficient dam management, snow surveys, and reliable weather forecasts the proposed Listowel Reservoir together with the minor channel improvement of Scheme B would be sufficient to satisfy Listowel's flood problem for the hypothetical spring flood. However, owing to the uncertainty of weather forecasts and even with the most efficient dam management the reservoir might be filled prematurely and with the hypothetical flood or floods of the magnitude of 1948 it might be necessary to divert some excess water. Considering the comparatively small drainage area of the Listowel reservoir site, it is not believed, however, that the volume of water diverted during spring floods would aggravate flood conditions on the Conestogo or Grand River to any great extent.

With severe summer storms occurring with the reservoir full or nearly full it might be necessary to divert a considerable volume if flooding is to be prevented at Listowel, and the worst probable conditions should be considered in order to show the maximum effect of the diverted waters on the Grand Watershed. For this purpose the freak storm of August, 1883, should safely serve as a yardstick for any future hypothetical summer flood. In this storm, as was previously shown, 6.25 inches of rain fell in a 24-hour period from noon of August 19th. The reservoir would probably be filled with the spring freshet run-off but, if not, it would certainly be full by the end of May (which is usually a wet month) when the drawdown for increased flow would commence. With discharge from the reservoir on a year-round basis that would provide a

minimum flow of 8 c.f.s., the reservoir by mid-August would still be about three-quarters full. However, in order to design the overflow spillway channel and determine the volume that would be diverted and its effect on the Conestogo River an extreme and highly improbable hypothetical storm is assumed, viz: 7 inches of rain in 24 hours over the Listowel drainage area, early in June with the reservoir full. At this time of year the ground would probably still be wet, but in any case with a storm of this intensity the surface would soon become saturated and therefore a 100 per cent run-off must also be assumed.

With these conditions there would be 3,617 acre feet of run-off into the reservoir. The sill of the overflow spillway would be at the same elevation as the top of the stop logs of the dam. The dam would be closed tight but water would be discharged over the stop logs under a 3-foot head (surcharge storage) leaving 2 feet of freeboard in the dam. Approximately 363 acre feet with a maximum flow of 335 c.f.s. would be discharged over the dam and approximately 3,267 acre feet with a maximum flow of 2,985 c.f.s. would be diverted into the Conestogo Watershed. These flows would be equivalent to a rate of run-off of 34.6 c.f.s./sq. mi. for the Listowel Dam drainage area and 13.6 c.f.s./sq. mi. for the Conestogo Dam drainage area.

Assuming that the 7-inch 24-hour rainfall was over the whole of the Listowel drainage area with 100 per cent run-off and as with the 1883 flood the duration at Listowel was 63 hours, then the run-off for the uncontrolled area would be 6,708 acre feet and the discharge over the stop logs of the dam 363 acre feet, which is equal to a total run-off of 7,071 acre feet. The calculated peak flow at Listowel would be 2,716 c.f.s. The capacity of the conduit for Scheme B is 2,343 c.f.s. approximately and flow would exceed the capacity of the conduit by 373 c.f.s. but, except for the low cellars

adjacent to the conduit, this added flow would not cause any serious flooding. There is a difference of 1.3 feet between the ceiling of the conduit at the entrance and the crown of the road of Wallace Street. The crown of the road opposite the entrance is 1,245.92. With 216 excess c.f.s. it is estimated that the water level would rise to 1,245.75, leaving only 0.17 feet or about 2 inches to spare at the entrance.

Based on past records a storm of this intensity would be limited to a comparatively small area, but it could be assumed to cover the whole of the drainage area and extend into the Conestogo as the 1883 storm actually did. On the other hand, it would not be reasonable to assume that it extended over the whole of the Conestogo Dam drainage area of 219.5 square miles. A hypothetical summer storm of 4.02 inches with 65 per cent run-off has been determined for the Grand Watershed, and in order to show what the maximum effect of diverting a peak flow of 2,985 c.f.s. would have on the Conestogo Reservoir, it is believed that if it is assumed that the 7-inch storm for the whole of the Listowel drainage area and the hypothetical summer storm for the Grand Watershed occurred and peaked simultaneously then the most adverse condition would be satisfied.

The calculated peak flow at the Conestogo Dam for the Grand hypothetical summer storm is 15,859 c.f.s.; with the diversion this could be (15,859+2,985) = 18,844 c.f.s. or an increase of 18.8 per cent.

The gates of the dam could easily discharge this extra inflow, but if the water level of the river below was already up to its channel capacity it would cause some minor flooding at those places. In order to prevent this, should such a condition arise, there would have to be an understanding that only a part or none of the water be diverted and Listowel be prepared for a flood. If the Grand Commission had control of the Listowel Dam, if only during flood periods, they should then have no objection to the diversion.

9. Summary

It has been shown that of the many spring floods that have occurred in Listowel the 1948 flood was the greatest spring flood,but that the greatest flood on record was actually a freak summer flood occurring in August 1883.

Works proposed for flood relief are based on a hypothetical flood which is 1-1/3 times greater than the 1912 flood. Three schemes have been submitted. Scheme A is for channel improvements alone and constitutes deepening, regrading and surfacing the bed of the channel from a point 180 feet up-stream from the conduit entrance to the crossing of the C.N.R. with reinforced concrete pavement through the conduit and heavy placed rip-rap above and below the conduit. Concrete training walls are recommended to connect the existing walls downstream from Bismark Street bridge to the entrance of the conduit and heavy rip-rap on the side slopes of the improved channel below the conduit is also recommended.

The concrete and masonry outside walls of the conduit and their foundations. are in a bad condition in many places and there are obstructions which cause extreme turbulence and restrict the flow. These should be cleaned out, made smooth and the damaged walls and foundations patched or replaced as the case may be. It is also recommended that the sections of centre wall and piers be connected to make continuous centre walls and that certain steel ceiling beams be raised a foot to increase the flow.

Further dikes are proposed, on the right bank from the exit of the conduit to the Maitland Mill and on the left bank from the exit of the conduit to the Canadian National Railway. There is sufficient material from the grading to build the dikes.

This scheme would greatly improve the appearance of the channel but it would not improve the present unsanitary conditions of the town. It would only benefit Listowel and would aggravate flood conditions downstream to some extent.

Scheme B is a conservation measure consisting of a dam and reservoir at the headwaters (the only available reservoir site) together with some minor grading, cleaning out and necessary repairs to the conduit. This scheme provides about the same flood protection as Scheme A but includes storage that would increase the low flows which for most of the summer and winter months now only amount to a trickle.

Scheme C provides the equivalent flood relief as the above two schemes but in addition includes a spillway diversion which permits further use of the reservoir storage capacity for the purpose of increased summer flows.

It has been pointed out that sewage effluent from septic tanks empties into the channel and that in some cases even raw sewage is emptied directly into the conduit from adjoining and overhead buildings. A proper sewer system and sewage treatment plant will be necessary eventually but an increase in the present low flows could reduce the cost of the treatment.

It has also been pointed out that if summer floods are to be avoided, space in the reservoir would have to be made available immediately after the spring run-off for subsequent rainstorms. The increase in low flows should be for the year round and not for the summer months only. The capacity of the reservoir is only 5,000 acre feet but if the reservoir has to be lowered to provide for summer floods, then the storage left would only be sufficient to increase the flow the year round by 2 c.f.s.; whereas if the reservoir could remain full after the spring run-off or was full by the end of May there would be a sustained minimum flow of 8 c.f.s.

This is possible if the Grand River Conservation Commission and the Grand Valley Conservation Authority would agree to the diversion of the surplus inflow of the Listowel Reservoir into the Conestogo Reservoir by means of an overflow spillway. It is believed that the surplus water diverted from

spring floods of the hypothetical magnitude, with efficient dam management, would have no adverse effect on the much larger Conestogo Dam drainage area; but if a hypothetical rainstorm should occur over both the Listowel and Conestogo drainage areas at a time when the reservoirs were full and peaked at the Conestogo Dam simultaneously, an improbable but conceivable condition, the amount diverted might increase the load on the Conestogo Dam by as much as 18.8 per cent. If, however, the Listowel Dam were controlled by the Grand River Commission, at least during flood periods, there would be no cause for concern.

CHAPTER 7

POLLUTION

Water pollution may be defined as the presence in water of substances or organisms which are dangerous to health or offensive to people and harmful to fish and other aquatic life.

Pollution may be considered in three classes, bacterial, organic and mechanical.

Mechanical pollution is the presence of substances which are stable, and not necessarily harmful, but which create a nuisance by their presence or properties which they may possess. In this classification are silts, chemicals, sawdust and coaldust. Chemicals may give the water "hardness", unpleasant tastes or noxious odours and even be toxic to fish or human life if in sufficient concentration. Silts and sawdusts may accumulate in reservoir space, overload filters or smother spawning beds and aquatic vegetation.

Organic pollution is the most widespread, and, although not necessarily harmful, may produce the most unpleasant conditions. Sources of this pollution are raw or incompletely treated sewage, organic industrial wastes, cattle droppings or swamp drainages.

It is this class of pollution which inspired the saying "running water purifies itself" since in time, through bacterial action and oxidation, it is converted to stable, inoffensive products. On the other hand, massive concentrations which require more oxygen than is available in the stream produce the conditions of foul bottom deposits, unpleasant odours and colours which are popularly associated with pollution.

The amount of oxygen required for complete oxidation of the pollution through bacterial action is known as the Biochemical Oxygen Demand (B.O.D.), and measurement

of this forms one of the most useful tests of degree of pollution.

Bacterial pollution, or the presence of disease organisms, is the most dangerous to humans, but when detected is comparatively simple to control. It is almost invariably the result of discharge of improperly treated sewage into the stream. An organism known as E. Coli is usually the means of detection, since it is readily recognizable and the number present in a sample gives a reliable measure of the degree of pollution.

The Middle Maitland River offers an almost text-book example of the effects of dumping massive quantities of untreated sewage into an inadequate stream.

Above Listowel the river is the typical Southern Ontario stream through agricultural land. Flowing from a small drainage area in heavy clay soils, summer flows drop to a very low level and, although no precise measurements are available at present, flow into Listowel has been observed at less than 1 c.f.s. Quality of the water appears good, and the Dissolved Oxygen (D.O.) content indicates a low level of organic pollution, as does the numerous small fish population in the pond upstream from the town.

In and below the town, however, the massive load of pollution added to the stream has resulted in conditions which are a serious potential hazard to public health, as well as constituting a nuisance to those living near the stream. This pollution takes the form of accumulations of putrescent sludge in the stream bed (benthal deposits), discolouration and noxious odours in the water. The benthal deposits are particularly noticeable in the covered sections of the channel, below the outfalls of several sewers. Domestic sewage is treated by individual septic tanks, and there is a strong presumption that the effluent of these, and possibly raw sewage, may find its way into the sewers. It is known that industrial

wastes are discharged through the sewers into the river without treatment.

The problem of abatement of the nuisance may be considered from a standpoint of oxygen balance, in which the amount of oxygen available in the stream (D.O.) is balanced against the amount required to neutralize the entering pollution (B.O.D.).

Stream flows in July and August drop to low levels, and residents state that flow has stopped altogether in dry periods. From the small drainage area, and heavy soil, a flow of 2 c.f.s. may be considered a high average for these months, and is probably exceeded only for short periods following heavy rains. A report of the Sanitary Engineering Division of the Department of Health states that the sewer discharge in May 1950 was greater than the stream flow.

Under the best conditions, at the average temperature of 68°F for these months, the amount of oxygen available from 2 c.f.s. is 100 pounds daily. A sample taken by the Department of Health showed a D.O. content of only 60 per cent of this optimum value. With the diversion of Scheme C in operation, and adding a further 8 c.f.s. to the flow, the maximum daily supply would be 500 lbs. of oxygen, or at the 60 per cent of saturation indicated by the sample, 300 pounds.

Against this supply, we must consider the demands upon it. The accepted figure for B.O.D. per capita per day is 0.25 lbs., which for the population of 3,515 served by the town water supply (1952) represents a B.O.D. of 879 lbs. per day. This figure is undoubtedly high under the present system of septic tank disposal but will apply in considering a treatment plant. In addition to the domestic wastes are those from industry in the town. These wastes form the bulk of the pollution now entering the stream and are largely responsible for the conditions existing there. It is difficult to form a

Even in April, the Maitland at Listowel has little flow.

Stagnant water below Listowel.

quantitative estimate of this pollution, but the wastes discharged from milk treatment, poultry dressing and textile plants are among those making the greatest demands on the purifying properties of the stream.

The present summer conditions in the stream through the town are such that no practicable augmentation of flow can have more than a slight palliative effect, and no scheme that does not include interception, collection and complete treatment of sewage should be considered. Even with complete sewage treatment and cleaning of the channel some increase in summer flow will be desirable, both for aesthetic reasons and to dilute the treatment plant effluent. On a B.O.D. basis alone, the design figure used in the estimate for a sewage treatment plant indicates the need for a flow of at least 2 c.f.s. throughout the summer months.

The conditions existing in the stream have been repeatedly brought to the attention of the Sanitary Engineering Branch of the Department of Health. At their request, the town engaged a firm of consulting engineers who submitted a report on a sewer system and treatment plant at a cost of $125,000. This was rejected by a plebiscite in 1949.

Instructions were then issued by the Department of Health that individual measures should be carried out for treatment of wastes, but little action has ensued in spite of repeated requests by the Department.

A later (1952) engineer's report covering intercepting sewers and plant at a cost of $204,000 has not been acted on.

At the present time the Pollution Control Board is arranging meetings with the interested parties in an attempt to arrive at a solution of the problem.

Conclusions

A serious pollution condition exists in the Maitland River at Listowel, due to unrestricted dumping of industrial and domestic wastes.

The massive scale of the pollution makes complete alleviation, by increased stream flow alone, impracticable.

Intercepting sewers and complete sewage treatment are necessary to reduce the pollution load to manageable proportions.

A flow of at least 2 c.f.s. to be maintained by operation of the flood control dam of Scheme B as set forth in the Water section, will be desirable, both to dilute the plant effluent and for aesthetic reasons in the town.

CHAPTER 8

THE MIDDLE MAITLAND RIVER AND BOYLE DRAIN IMPROVEMENT

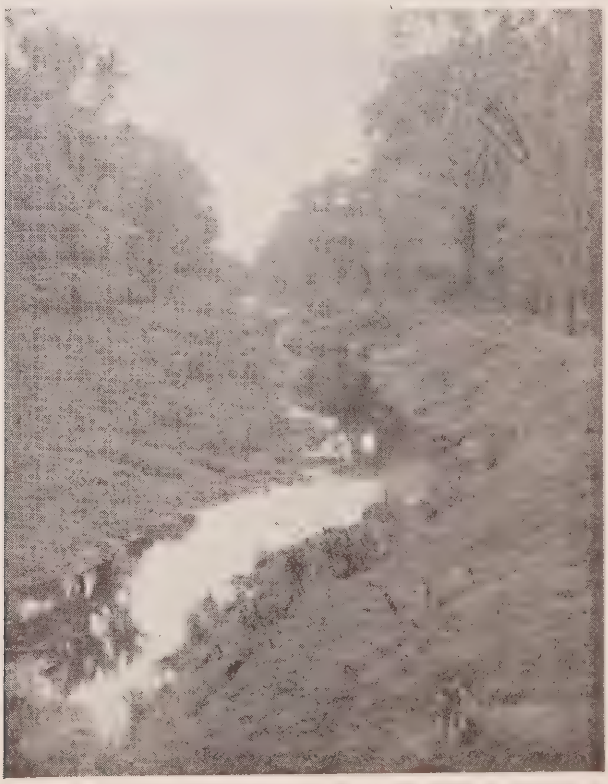
Application for assistance under *The Municipal Drainage Act* has been made by the Township of Grey for certain channel improvement in the Boyle Drain area, and it is really no concern of this report. However, since the flood control measures for Listowel will to some extent affect the flows in the Boyle Drain, a brief description of this proposed channel improvement will be made.

The area under consideration is the low-lying land surrounding the confluence of the Boyle Drain and Middle Maitland River (Fig. H-2). In the past this area has suffered from several severe floods, with some degree of flooding occuring almost annually during the spring break-up period. Flash summer floods also occur from time to time due to excessive rainfall, and while these floods are usually of lesser magnitude, they cause heavy crop damages and are often equally as costly as the greater spring floods. During a severe flood as much as 3,900 acres of land may be inundated.

The drainage area above this point consists of 164 square miles drained by the upper Middle Maitland River and the Boyle Drain. This area is comparatively flat, but it is intensively cultivated and has a widespread network of drainage and channel improvement works, which rapidly convey the storm waters to the confluence of the two main streams. The Township of Grey has carried out extensive channel improvement work during the years 1921 to 1940 in an effort to improve this area, but none of this work provided sufficient outlet capacity for the storm waters, and in 1950 Mr. G. Graham Reid, Township Engineer, was instructed to investigate the situation.

The investigation was subsequently carried out and a detailed report on the Engineer's findings was submitted to the Township Council in October of that year. This report proposed straightening, widening and deepening

New drain in peat at headwaters of Boyle Drain.



Previously "improved" channel of Middle Maitland, eight miles below Listowel.

the Boyle Drain from the boundary between the Townships of Elma and Grey to its outlet in the Middle Maitland River, and likewise straightening, widening and deepening the Middle Maitland River channel from the confluence of the Boyle Drain to an outlet in Lot No. 20, Concession IX, Township of Grey, below which a sufficient outlet has already been provided. This entails the construction of a channel 5.5 miles long (Fig. H-11). The channel would be trapezoidal in cross-section, with a 50-foot bottom width and 1:1 side slopes. The channel grade would be 0.4 feet per 1,000 feet, and it would have a discharge capacity of 4,500 c.f.s. with a water depth of 14 feet. Total cost of the project, including land damages and engineering, has been estimated at $149,640 (October, 1950).

This channel would not provide complete protection for all times, but based on a study of the flow records and local observations, it would prevent about 60 per cent of the floods and substantially reduce the extent of inundation for the more severe floods. The cost of providing complete protection would be prohibitive and out of all proportion to the benefits to be achieved.

As indicated earlier in this report, three schemes have been prepared to provide flood protection for the town of Listowel. Scheme A would provide the required relief through channel improvement work alone, but the benefits of this proposal would be entirely local and no doubt the flooding conditions downstream would be somewhat aggravated. On the other hand Schemes B and C, which would provide some reservoir storage supplemented by a limited amount of channel improvement work, would offer some measure of relief to points along the river below Listowel as well.

The proposed Listowel Reservoir would control the run-off from 9.7 square miles, or about six per cent of the total drainage area above the Boyle Drain area, but, due to the higher rate of run-off in the headwater areas, the

mitigating influence of the reservoir could be expected to be slightly greater than the area proportion would indicate and would probably reduce the volume of flood waters at the Boyle Drain area by as much as ten per cent.

The Middle Maitland and Boyle Drain Improvement Scheme was opposed by the Townships of Elma, Ellice, Mornington, Maryborough and Wallace, the Town of Listowel and the Village of Milverton and a notice of appeal was filed in the Ontario Drainage Court. A hearing was subsequently held by the Ontario Municipal Board and on the basis of the evidence presented the scheme was rejected by the Board, April 28, 1954.

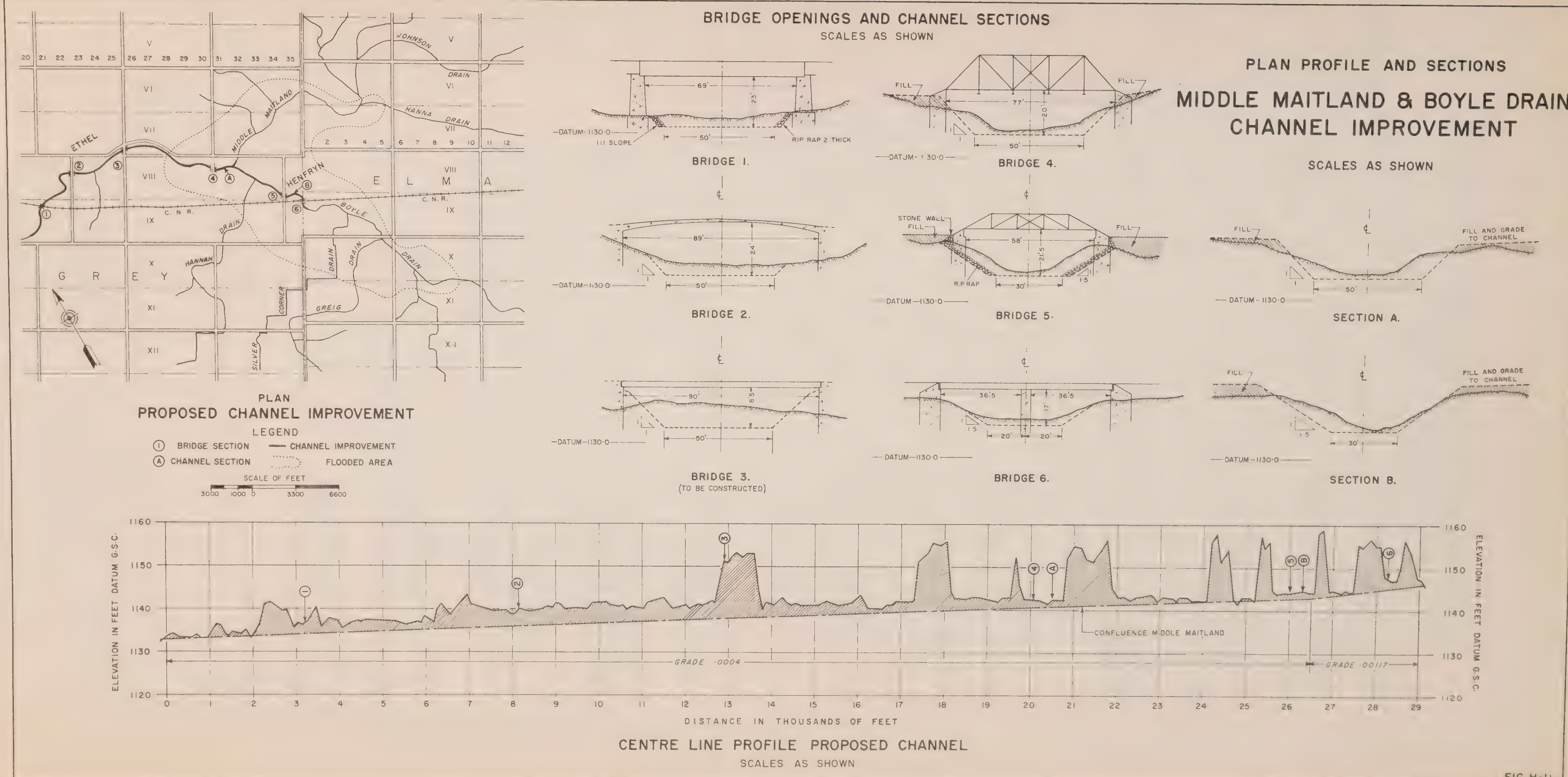

PLAN PROFILE AND SECTIONS
MIDDLE MAITLAND & BOYLE DRAIN
CHANNEL IMPROVEMENT
SCALES AS SHOWN
BRIDGE OPENINGS AND CHANNEL SECTIONS
SCALES AS SHOWN
BRIDGE 1.
69'
23'
50'
1:1 SLOPE
RIP RAP 2 THICK
DATUM-1130·0
BRIDGE 2.
89'
24'
50'
DATUM-1130·0
BRIDGE 3.
(TO BE CONSTRUCTED)
90'
8·5
50'
DATUM-1130·0
BRIDGE 4.
FILL
77'
20'
50'
DATUM-1130·0
BRIDGE 5.
STONE WALL
FILL
58'
21·5
30'
R.P. RAP
1·5
DATUM-1130·0
BRIDGE 6.
36·5
17'
20'
1·5
DATUM-1130·0
SECTION A.
FILL
FILL AND GRADE TO CHANNEL
50'
DATUM-1130·0
SECTION B.
FILL
FILL AND GRADE TO CHANNEL
30'
1·5
DATUM-1130·0
PLAN
PROPOSED CHANNEL IMPROVEMENT
LEGEND
BRIDGE SECTION
CHANNEL SECTION
CHANNEL IMPROVEMENT
FLOODED AREA
SCALE OF FEET
3000 1000 0 3300 6600
GREY
ELMA
ETHEL
HENFRYN
C. N. R.
MIDDLE MAITLAND
JOHNSON DRAIN
HANNA DRAIN
BOYLE DRAIN
HANNAH DRAIN
CORNER DRAIN
GREIG
SILVER
CENTRE LINE PROFILE PROPOSED CHANNEL
SCALES AS SHOWN
ELEVATION IN FEET DATUM G.S.C.
DISTANCE IN THOUSANDS OF FEET
GRADE ·0004
GRADE ·00117
CONFLUENCE MIDDLE MAITLAND

FIG. H-11

HYDRAULIC ABBREVIATIONS, EQUIVALENTS AND DEFINITIONS

Abbreviations

c.f.s. is the abbreviation for cubic feet per second and is the unit generally used to express discharge or the rate of flow.

c.s.m. is the abbreviation for cubic feet per second per square mile and is the average number of cubic feet of water flowing per second from each square mile of drainage area.

ac. ft. is the abbreviation for acre foot which is equivalent to 43,560 cubic feet and is the quantity of water required to cover one acre to a depth of one foot.

Equivalents

1 c.f.s. = 6.25 imperial gallons per second.

1 c.f.s. for 1 day = 1.98347 acre feet or approximately 2 acre feet.

1 c.f.s. for 1 year = 724 acre feet.

1,000,000 imperial gallons per day = 1.86 c.f.s.

Definitions

HYDRAULICS as applied to conservation deals with the measurement and control of run-off from river drainage basins.

HYDROLOGY is the science which deals with the occurrence and distribution of water in its various forms over and within the earth's surface. As applied to conservation it deals more specifically with that portion of the hydrologic cycle from precipitation to re-evaporation or return of the water to the seas and embodies the meteorological phenomena which influence the behaviour of the waters during this phase of the cycle.

RUN-OFF is the amount of water which reaches the open stream channels and may be broadly defined as the excess of precipitation over evaporation, transpiration and deep-seepage.

RATE OF RUN-OFF is the rate at which water drains from an area. Usually expressed in cubic feet per second (c.f.s.).

RATE OF RUN-OFF PER SQUARE MILE is the average number of cubic feet per second of water flowing from each square mile of area drained (c.f.s./sq.mi. or c.s.m.).

RUN-OFF DEPTH IN INCHES is the depth to which the area would be covered if all the water flowing from it were conserved and uniformly distributed over the surface.

FLOOD is an overflow or inundation coming from a river or other body of water.

FLOOD CONTROL is the prevention of flooding by controlling the high water stages by means of storage reservoirs, dikes, diversions or channel improvement such as widening, deepening and straightening.

FLOOD STAGE is an arbitrary flow stage which varies from place to place and from season to season and is that flow or water level at which the water threatens to do damage.

FLOOD CREST is the maximum height or stage that the flood waters reach during any one flood period.

FLOOD RATIO is the rate of peak flow to the average flow for the flood period.

DAM is a structure in and across a river valley to impound, control and otherwise regulate the river flow.

SPILLWAY is that part of a dam over which the excess water is discharged.

SPILLWAY CAPACITY is the maximum amount of water that may be discharged over the spillway without exceeding the maximum permissible water level in the reservoir.

DISCHARGE TUBE or CONDUITis an opening through the base of the spillway to provide means for discharging water when the water level of the reservoir is below the spillway level.

RESERVOIR is the body of water created by the construction of a dam.

RESERVOIR CAPACITY is the maximum amount of water that may be contained within the reservoir without exceeding the maximum permissible water level. Usually expressed in acre feet.

FREEBOARD is the vertical distance between the maximum permissible water level and the top of the dam.

DEAD STORAGE is the amount of water kept in a reservoir at all times for the purpose of protecting the artificial and natural water seals at the base of the dam.

BOOST STORAGE is the storage required to increase the head of water over the discharge tubes in order that they may be able to discharge the required flow.

CHANNEL CAPACITY STORAGE is the volume of water that must be impounded in order that the stream flow will not exceed the channel capacity flow or stage.

OPERATIONAL STORAGE is additional storage that is required to provide a safety factor to enable the controller to regulate the discharge from a dam so as not to exceed the channel capacity flow or stage.

CONSERVATION STORAGE is that volume of water remaining in a reservoir which may be used to augment the low flows and is equivalent to the maximum storage capacity of the reservoir less the dead storage, evaporation and ice losses and the space reserved for flash floods.

FLOOD CONTROL STORAGE is the total volume of water that must be impounded during a given flood in order that the stream flow will not exceed the channel capacity flow or stage and is equal to the sum of the channel capacity, dead, boost and operational storages.

CHANNEL CAPACITY or "IN-BANK" FLOW is the maximum flow which is contained within the river banks and does not overflow the adjacent low lands.

STREAM GAUGE is a measuring device used to determine the elevation of the water surface at selected points. - Usually a graduated rod fixed in an upright position and set to a known elevation from which the gauge readings are obtained by direct observation. Automatic type gauge is a mechanically operated recording instrument which gives a continuous record of recorded water surface elevations.

HYDROGRAPH is a plot of flow against time and is a correct expression of the detailed run-off of a stream resulting from all the varying physical conditions which have occurred on the drainage area above the gauging station previous to the time which it represents.

FLOOD HYDROGRAPH - a hydrograph which covers only the flood period or time interval during which the river flow is above the flood stage.

WATER or CLIMATIC YEAR is a 12-month period from October 1 to September 30. The water year was found to be a more convenient form than the calendar year for the purpose of stream flow studies as it groups together those months in which the water losses due to evaporation and vegetation demands are at a minimum (October - March) and those during which the losses are high (April - September).